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THE SYNOP EXPERIMENT: Inverted Echo Sounder Data Report for May 1988 to Aug 1989

GSO Technical Report No. 90-2

by

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Abstract

The SYNoptic Ocean Prediction experiment (SYNOP) was undertaken with the goal that increased understanding of the Gulf Stream obtained through coordinated observations could be integrated with numerical models, including predictive models of the Gulf Stream. Our moored experiment, which began in fall of 1987, consists of two separate arrays in the Gulf Stream as part of the SYNOP program. The "Inlet" array of inverted echo sounders (IES) and deep current meters measure key parameters that describe the variability of the Gulf Stream and deep western boundary current (DWBC) near Cape Hatteras. In this region the Gulf Stream first flows into deeper water and crosses over the DWBC. The "Central" array of IESs, in a 350 km square centered on the Gulf Stream near 68°W, monitors the thermocline structure of the Gulf Stream in the region of large meanders and frequent interactions with rings. The array also contains twelve tall current meter moorings, that reach into the Gulf Stream core. Additionally most of the IESs in the interior of the array are outfitted with bottom pressure recorders (PIES).

IES data recovered during the summer of 1989 is documented here by plots and tables of basic statistics and pertinent deployment information. Altogether 33 IES records are presented, plus pressure records at 10 sites. The echo sounders were recovered during two cruises of the RV Oceanus, OC207 (26-May-89 to 21-Jun-89) and OC210 (8-Aug-89 to 1-Sep-89). The plots are time series of measured travel time, pressure, temperature; the residual pressure; and low-pass filtered records of residual pressure, thermocline depth, and temperature. A brief description of the experiment is given, the standard steps of data processing and special processing for three IES records that had different problems are discussed.

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1 Experiment Description and Data processing

1.1 Introduction

In the region northeast of Cape Hatteras, NC, the Gulf Stream has large time-varying meanders. The current shifts within an envelope that grows downstream to several times the instantaneous width of the Gulf Stream itself, and it frequently interacts with powerful currents in eddies adjacent to the Gulf Stream. Fundamental questions remain regarding the dynamics and energy balances governing the meandering. A multi-investigator research effort **SYN**optic **O**cean **P**rediction (SYNOP) is being conducted to understand the physics of, and test predictive models of these energetic processes. Our field program is completing the two-year deployment of arrays of high-performance current meter moorings, reaching into the core of the Gulf Stream, and inverted echo sounders with bottom pressure gauges. The arrays are specifically designed for our objectives to understand the structure and energy exchanges associated with Gulf Stream variability throughout an extensive region where meanders are large and frequent interactions with eddies occur.

The present study aims to understand the structure, energetics, and dynamics of the Gulf Stream in the region between 70° and 65° W, where meanders are of large amplitude and still growing, and where the adjacent ring and eddy field is vigorous.

Using data from current meters, inverted echo sounders (IESs) and IES/bottom pressure sensor combinations, we intend to determine how the path and structure of the Gulf Stream evolve, both according to its internal dynamics and instabilities, and as affected by eddies in the adjacent regions. The full three-dimensional structure of the fluctuations in relation to the mean (T, U, V) fields and their gradients determines the directions and strengths of the key energy exchanges between them. The main objective of our program is a more complete, fundamentally improved understanding of these processes. From this understanding the longer term goal is to guide and test a predictive modeling capability for the Gulf Stream.

IES data were recovered during the summer of 1989 which span from the previous summer. These records were recovered on two cruises aboard the R/V Oceanus, OC207 (26-May-89 to 21-Jun-89) and OC210 (8-Aug-89 to 1-Sep-89). One other IES was recovered during OC213 (8-Oct-89). The data are presented in plots of travel times, thermocline depth measurements, and for IES's with additional sensors, bottom pressure and temperature. Basic statistics for those records and pertinent deployment information are given in tables.

Work is also underway on data being received from five telemetry instruments (TIES's) in the inlet array. The TIESs and associated moorings were deployed during OC210. The IES sites (Figure 1) will continue to be occupied until Aug-1990.

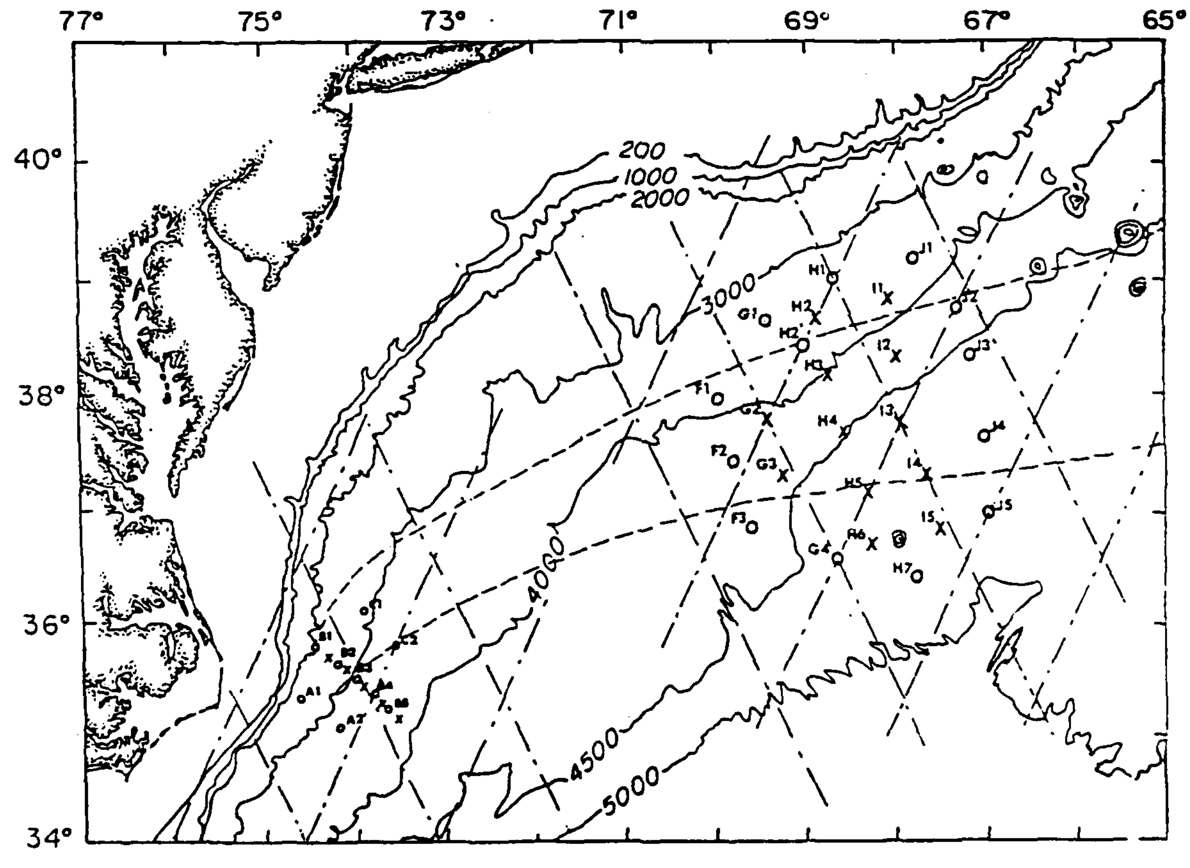


Figure 1: Mooring and IES sites. In the inlet array 'X's denote deep current meter moorings; in the central array they indicate tall current meter moorings. IESs are located at these sites and at locations marked by the 'O's. The two dashed curves indicate the ± 1 std dev envelope of the Stream path. The broken lines crossing diagonally represent the ground tracks of the GEOSAT satellite.

1.2 Site Naming Conventions

Two arrays exist (Figure 1), an "Inlet Array" near Cape Hatteras consisting of 9 IESs on 3 lines designated A–C, and a "Central Array" centered on the Gulf Stream about 68 W with 5 instrument lines, F–J. There are 24 instruments in the central array and 12 of those located in the array's interior at current meter mooring sites are outfitted with bottom pressure recorders. These IES's are referred to as PIES's.

The instrument naming convention is to specify the line and the relative position in the line (increasing seaward from the shelf) prefixed by the type of instrument type and year of recovery. For example PIES89H3 would refer to the third instrument, a pressure outfitted IES, in the H line. Thirty-seven IES sites were visited this summer (Figure 1 and 2, Tables 1 and 2). There were only 33 sites in the arrays; some of the sites were revisited for second recoveries. Since some instrument sites had multiple recoveries the associated cruise number of the recovery (207, 210, or 213) will be concatenated to make deployment specification clear.

Site Locations and Data Returns

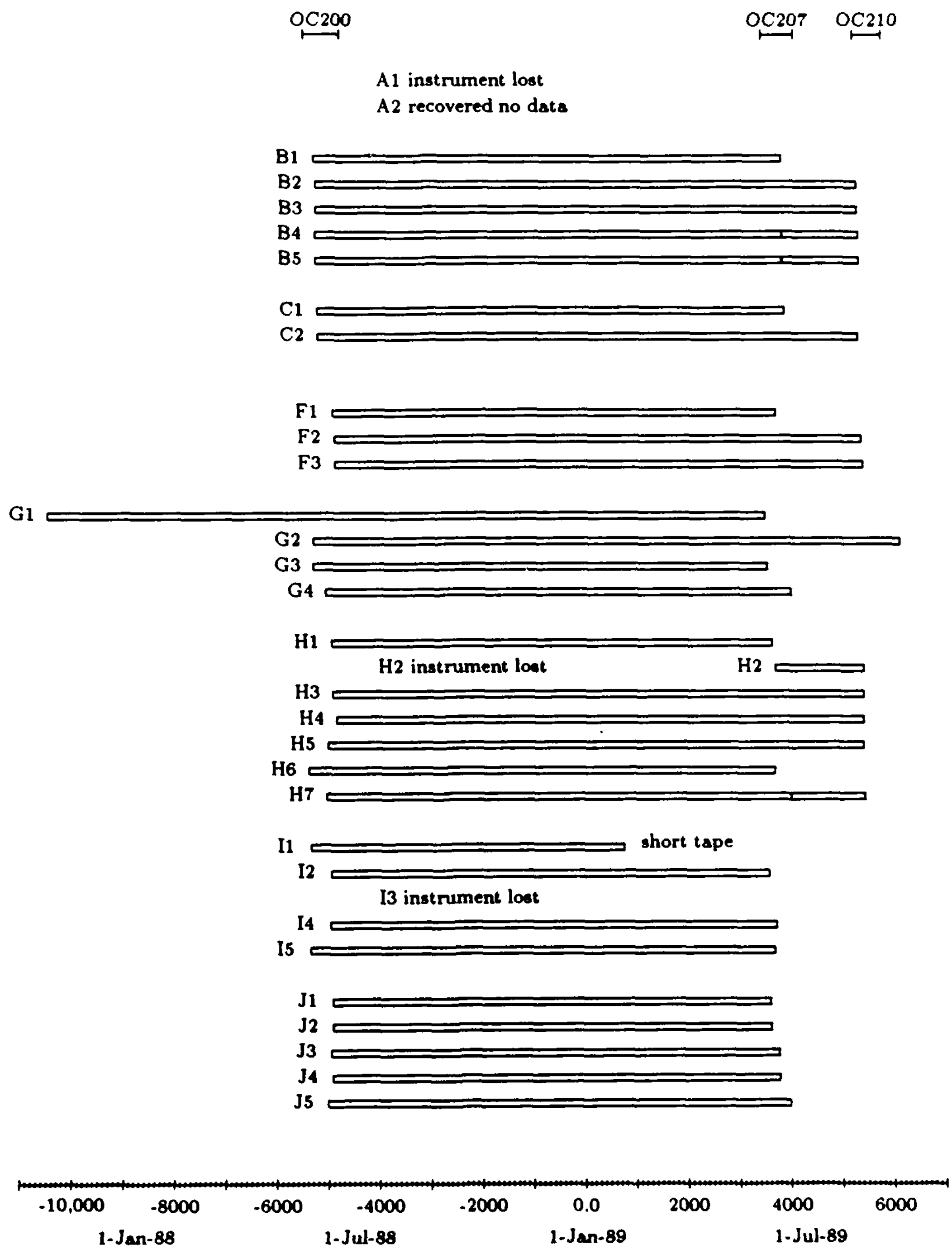
Table 1: Central Array

site	lat(N)	lon(W)	1st point	last point	notes
IES89F1	37° 56.94	69° 57.98	12-Jun-88	05-Jun-89	
IES89F2	37° 24.40	69° 46.50	14-Jun-88	14-Aug-89	
IES89F3	36° 42.10	69° 33.60	14-Jun-88	14-Aug-89	
IES89G1	38° 37.64	69° 25.28	24-Oct-87	27-May-89	two track reconstruction, quality lower
PIES89G2	37° 47.52	69° 24.33	27-May-88	12-Sep-89	time released
PIES89G3	37° 17.40	69° 14.53	26-May-88	29-May-89	
IES89G4	36° 33.19	68° 40.49	06-Jun-88	17-Jun-89	
IES89H1	39° 00.00	68° 40.32	11-Jun-88	02-Jun-89	
PIES89H2	38° 37.88	68° 54.20	lost		faulty release
IES89H2′	38° 25.80	69° 02.00	05-Jun-89	15-Aug-89	15 km down GEOSAT line from lost H2
PIES89H3	38° 10.10	68° 43.30	11-Jun-88	15-Aug-89	
PIES89H4	37° 39.80	68° 35.40	14-Jun-88	15-Aug-89	
PIES89H5	37° 10.60	68° 17.00	07-Jun-88	14-Aug-89	
PIES89H6	36° 40.45	68° 15.64	23-May-88	03-Jun-89	
IES89H7	36° 24.53	67° 47.06	06-Jun-88	17-Jun-89	
IES89H7	36° 24.90	67° 48.10	17-Jun-89	16-Aug-89	recovered to check detector, was fine
PIES89I1	38° 47.54	68° 06.38	25-May-88	01-Feb-89	insuffícent tape, ended 4 month early
PIES89I2	38° 20.90	67° 59.60	09-Jun-88	30-May-89	
PIES89I3	37° 47.55	67° 56.50	lost		no response
PIES89I4	37° 18.50	67° 39.30	08-Jun-88	16-Jun-89	
PIES89I5	36° 49.73	67° 27.57	23-May-88	03-Jun-89	tape errors, data quality lower
IES89J1	39° 10.04	67° 47.08	10-Jun-88	30-May-89	
IES89J2	38° 45.59	67° 21.57	10-Jun-88	31-May-89	
IES89J3	38° 09.03	67° 10.06	09-Jun-88	06-Jun-89	
IES89J4	37° 37.84	67° 00.65	10-Jun-88	07-Jun-89	
IES89J5	36° 59.83	66° 56.52	06-Jun-88	16-Jun-89	

Table 2: Inlet Array

site	lat(N)	lon(W)	1st point	last point	notes
IES89A1	35° 18.61	74° 36.85	lost		wouldn't leave bottom
IES89A2	34° 58.06	74° 24.96	recovered no data		cold soldier joint on detector card
IES89B1	35° 45.10	74° 28.00	28-May-88	10-Jun-89	
IES89B2	35° 36.92	74° 14.20	30-May-88	10-Aug-89	replaced by telemetry IES
IES89B3	35° 28.96	74° 02.63	29-May-88	10-Aug-89	replaced by telemetry IES
IES89B4	35° 20.70	73° 51.00	29-May-88	11-Jun-89	
IES89B4	35° 20.80	73° 50.50	11-Jun-89	11-Aug-89	replaced by telemetry IES
IES89B5	35° 12.06	73° 40.01	29-May-88	10-Jun-89	
IES89B5	35° 12.04	73° 39.95	11-Jun-89	11-Aug-89	replaced by telemetry IES
IES89C1	36° 04.67	73° 56.90	31-May-88	12-Jun-89	
IES89C2	35° 46.20	73° 32.90	31-May-88	11-Aug-89	

Figure 2: IES deployment Chart. The duration and temporal location of each IES is charted as a thin rectangle. The length of each rectangle and its horizonal position on the time axis, in yearhour at the bottom, provide a calendar of data coverage, first good ping to last. Each large tic is 1000 hr and the smaller tics denote 100 hr increments.



1.3 Inverted Echo Sounder Description

A detailed description of the IES is presented in Chaplin and Watts (1984) and will not be repeated here. Briefly, however, the IES is an instrument which is moored one meter above the ocean floor and which monitors the depth of the main thermocline acoustically. A sample burst of acoustic pulses is transmitted every half hour. A sample burst consists of twenty-four 10 KHz pings. The round trip travel times to the surface and back are recorded on a digital cassette tape within the instrument. For the PIES's, the measured bottom pressure and temperature are also written to tape at that time. Pressure is an average measurement over a half hour sampling period. (For early model PIES's the temperature is also an average measurement over a half hour sample period. Later models average for slightly less than a minute. In section 1.4.5 this will be explained in detail relative to the actual times associated with the measurements.)

1.4 Data Processing

Processing was done on MicroVAX II and MicroVAX III computers. The basic steps include transcription, editing, and conversion into scientific units. The data processing is accomplished by a series of routines specifically developed for the IES. Since these programs are documented elsewhere (Fields, Tracey, and Watts, 1990), the steps are only outlined below (Figure 3).

RAW DATA CASSETTES : Recorded within the instruments. Contain the counts associated with travel time, pressure, and temperature measurements as a series of integer words of varying lengths.

SDR : Runs the Sea Data Reader which transfers the data from cassettes to the MicroVAX for subsequent processing.

BUNS : Converts the series of integer words of varying lengths into standard length 32-bit integer words.

PUNS : Produces integer listings and histograms of the travel time sample bursts. Provides an initial look at data quality and travel time distributions. The histogram is used to determine the limits for maximum and minimum acceptable travel times for

an initial windowing operation in the following step.. The listings are used to establish the first (after launch) and last (before recovery) 'on bottom' samples essential for exacting the time base.

MEMOD : Establishes the time base. Determines the modal value of the travel time burst as the representative measurement after application of several windowing operations. Converts all travel time, pressure and temperature counts into specific units of seconds, decibars, and degrees Celsius, respectively.

FILL : Checks for proper incrementing of the time base. Missing samples are inserted using interpolated values.

DETIDE : From user-supplied tidal constituents specific to each site, determines the tidal contribution to the travel times and removes it from the measured values.

DESPIKE : Identifies and replaces travel time spikes with interpolated values.

SEACOR : Removes the effects of seasonal warming and cooling of the surface layers from the travel times. At this stage plots of the half-hourly pressure, temperature and travel time are generated.

RESPO : Removes the tides from the pressure records using tidal response analysis (Munk and Cartwright, 1977) to determine the tidal constituents for each record.

DEDRIFT : Removes long term drifts associated with the pressure sensor and slight imperfection in the IES master clock frequency.

LOW PASS FILTERING : A 2nd order 40 hr low-pass Butterworth filter is applied forward and backwards to the travel time, residual pressure, and temperature records. The smoothed series are subsampled at six hour intervals and plotted. The smoothed subsampled travel time is subsequently calibrated to Z_{12}.

OBJECTIVE MAPPING : Produces daily maps of the depth of the 12°C isotherm as documented in Watts, Tracey and Friedlander, 1988. The results of this step are not presented here. Rather they will be presented in a subsequent data report.

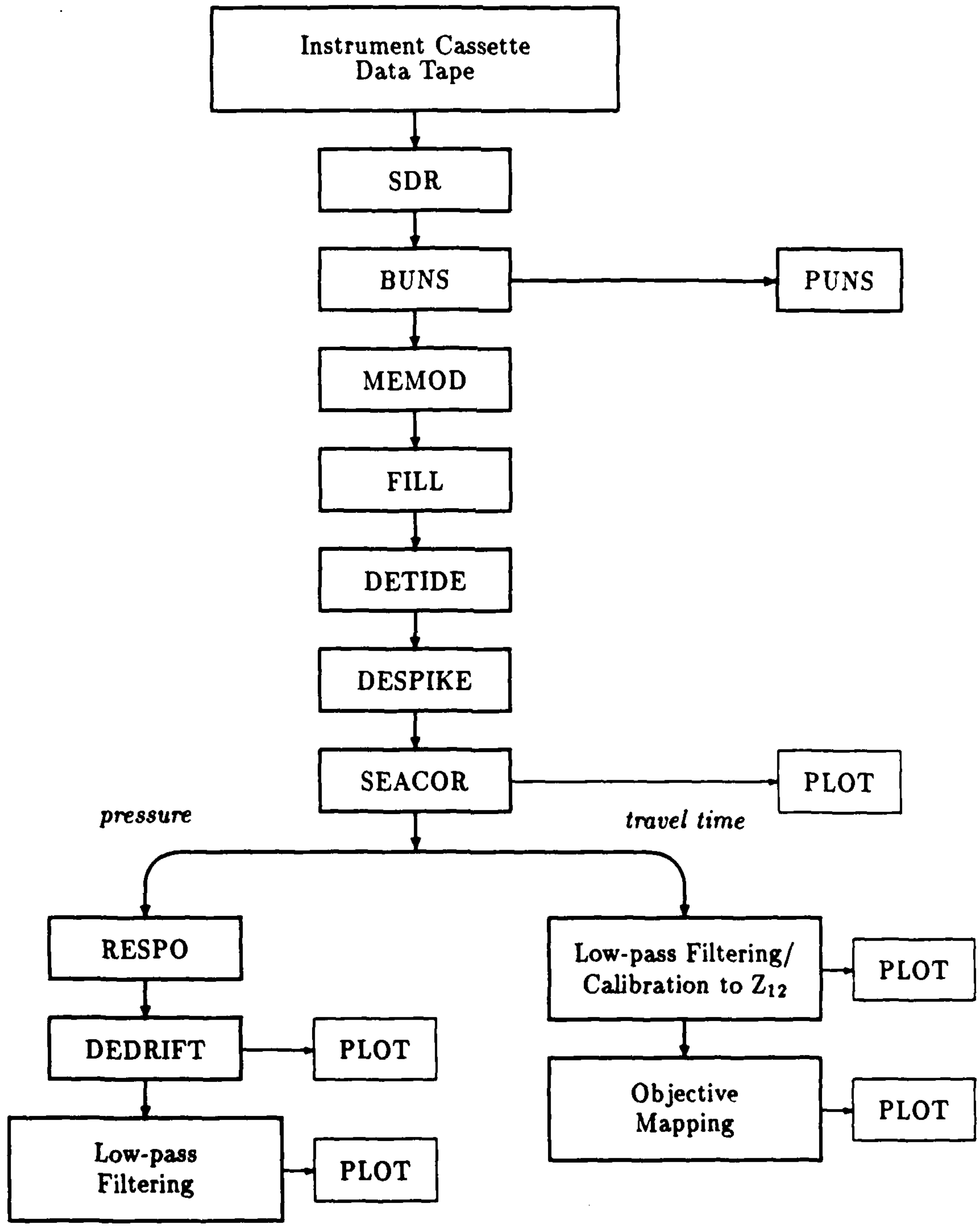


Figure 3: IES Data Processing Flowchart

1.4.1 Travel Time Calibration

The acoustic travel times (τ) records are shown in Figures 6.1– 6.33. Variations in the travel times have been shown to be proportional to variations in the thermocline depth in the Gulf Stream (Watts and Rossby, 1977; Watts and Wimbush 1981, Watts and Johns, 1982). Calibration XBTs were taken at each IES site in order to convert the travel times (τ) into thermocline depths (ξ) according to the relation: $\xi = M\tau + B$, where M is a scale factor and the intercept B depends on the depth of the instrument. Regressions of τ versus ξ, performed for several instruments, show that the constant (M) value, M = −19.0 m/msec for the 12°C isotherm, is appropriate for all these Gulf Stream sites. The values of B used for each instrument are listed in the tables in Section 2. For practical purposes the main thermocline depth can be represented by the depth of an individual isotherm. For this work, we have chosen the 12°C isotherm since it is situated near the highest temperature gradients of the main thermocline and correlates well with τ (Rossby, 1969; Watts and Johns, 1982). The low-pass filtered travel time records were scaled to the thermocline depths (Z_{12}) and these records are shown in Figures 13.1– 13.7. Since τ is resolved to 0.1 msec, the 40 HRLP Z_{12} scaled values are therefore resolved to ±2 m. However, the accuracy of the offset parameter B is estimated to be ±25 m for most instruments, judged from the agreement between the several calibration XBTs taken at each site. Relative to this, the 40 HRLP Z_{12} values are resolved to ±2 m.

1.4.2 Temperature

Temperatures (Figures 8.1–8.10, 12.1–12.3, and 15.1–15.3) were measured using thermistors (Yellow Springs International Corp., model 44032) controlled by Sea Data Corp. (model DC-37B) electronics cards installed in the IESs, in order to correct the pressure values for the temperature sensitivity of the transducer. The thermistor is inside the instrument, on the pressure transducer, rather than in the water. However, once the temperature probe has reached equilibrium with the surrounding waters, it also provides accurate measurements of the bottom temperature fluctuations (effectively low-pass filtered with a 2-4 hour e-folding equilibrium time). The first 24 half-hourly points were dropped prior to low-pass filtering, since the temperatures took 12 hours to reach equilibrium within 0.001°C. The accuracy of

the temperature measurements is about 0.1°C, and the resolution is 0.0002°C.

1.4.3 Bottom Pressure

Digiquartz pressure sensor (models 46K-017, 46K-023, and 76KB-032) manufactured by Paroscientific Inc. were used to measure bottom pressure. All pressure measurements were corrected for the temperature sensitivity of the transducer, using calibration coefficients purchased from the manufacturer. The half-hourly measured bottom pressures (Figures 7.1–7.10) are dominated by the tides, however for some of the instruments, the pressures also drift, 0(0.1 dbar yr^{-1}), monotonically with time. Processing of the pressure measurements includes removing the long-term drift and tides.

Tidal response analysis (Munk and Cartwright, 1977) was used to determine the tidal constituents for each instrument. The calculated tides were then removed from the pressure records. The amplitudes, H (dbar), and phases, G° (Greenwich epoch), of the constituents are given in the tables in Section 2.

The pressure records were dedrifted in the same manner developed by Watts and Kontoyiannis (1990) who have addressed pressure sensor drift and performance. In some records the first 10-40 days exhibit a drift of tenths of decibars. The rate of drift decayed with time and was best approximated by a exponential function. Drifts may also have resulted from slight monotonic drift in the PIES's master clock (O(1 min) in a year long deployment). When present, the form of the drift curve on which the ocean signal resides was chosen to be either exponential, linear, or a combination of the two. Linear drifts were removed when calculations suggested the drift could be explained by a drifting master clock. For the most general form of the drift curve,

$$Drift = P_1 \exp(-P_2 t) + P_3 + P_4 t$$

a design matrix would be composed of $(exp(-P_2 t_i),\ t_i,\ 1)$. The overdetermined set of equations werre solved for coefficients P_1, P_3, and P_4. These coefficients were found subject to the minimization of the rms error of the fit as a function of the decay rate, P_2. Minimization was accomplished using the method of parabolic extrapolation and golden sections (Press

et al, 1986) to optimally search for P_2 with a minimum of function evaluations (fits). The first 12 hr of pressure were ignored since the crystal's temperature was equlibrating. The dedrfted curves were found from the 2 hr subsampled records for computational simplicity. The time was referenced from 1 hour before the first good sample. At a later stage, comparison of geostrophic currents, calculated from adjacent dedrifted pressure sensors versus nearby current meters will be used to verify the dedrift procedure's success.

Half of the ten PIES showed some sign of drift. Of the five, one was identified as exponential/linear, two were pure exponential, and the remaining two were pure linear. The fitted drift parameters are listed for each instrument individually, in the site and record information tables of Section 2. The half-hourly pressures are resolved to 0.001 dbar and the mean pressure is accurate to within 1.5 dbar. We estimate that the residual (drift and tide removed) bottom pressure records, shown in Figures 9.1–9.10, have an accuracy (relative to their mean pressure) of better than 0.05 dbar (Watts and Kontoyiannis, 1986). The residual bottom pressure records were low-pass filtered (Figures 14.1–14.3) as mentioned above.

1.4.4 Time Base

The date and time were assigned to each sampling period. The Tables (Tables 4- 36) in Section 2 report the hours, minutes, and seconds associated with the first and last sampling period as a six-digit number. For the six-hourly subsampled records the times are reported as four-digit numbers. All times are given as Greenwich Mean Time (GMT). For processing convenience, the times were converted into yearhours. A yearhour calendar (Table 3) lists the yearhours which correspond to 0000 GMT of each day for non-leap years. (For leap years, the yearhours can be determined by adding 24 to each day after February 28.) There are a total of 8760 hours in a standard year and 8784 hours in a leap year. The yearhours given in this report are referenced to January 1, 1989 at 0000 GMT.

Table 3: Yearhour Calendar for Non-Leap Years. Yearhours listed correspond to 0000 GMT of date.

Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Day	yrhr																						
1	0	1	744	1	1416	1	2160	1	2880	1	3624	1	4344	1	5088	1	5832	1	6552	1	7296	1	8016
2	24	2	768	2	1440	2	2184	2	2904	2	3648	2	4368	2	5112	2	5856	2	6576	2	7320	2	8040
3	48	3	792	3	1464	3	2208	3	2928	3	3672	3	4392	3	5136	3	5880	3	6600	3	7344	3	8064
4	72	4	816	4	1488	4	2232	4	2952	4	3696	4	4416	4	5160	4	5904	4	6624	4	7368	4	8088
5	96	5	840	5	1512	5	2256	5	2976	5	3720	5	4440	5	5184	5	5928	5	6648	5	7392	5	8112
6	120	6	864	6	1536	6	2280	6	3000	6	3744	6	4464	6	5208	6	5952	6	6672	6	7416	6	8136
7	144	7	888	7	1560	7	2304	7	3024	7	3768	7	4488	7	5232	7	5976	7	6696	7	7440	7	8160
8	168	8	912	8	1584	8	2328	8	3048	8	3792	8	4512	8	5256	8	6000	8	6720	8	7464	8	8184
9	192	9	936	9	1608	9	2352	9	3072	9	3816	9	4536	9	5280	9	6024	9	6744	9	7488	9	8208
10	216	10	960	10	1632	10	2376	10	3096	10	3840	10	4560	10	5304	10	6048	10	6768	10	7512	10	8232
11	240	11	984	11	1656	11	2400	11	3120	11	3864	11	4584	11	5328	11	6072	11	6792	11	7536	11	8256
12	264	12	1008	12	1680	12	2424	12	3144	12	3888	12	4608	12	5352	12	6096	12	6816	12	7560	12	8280
13	288	13	1032	13	1704	13	2448	13	3168	13	3912	13	4632	13	5376	13	6120	13	6840	13	7584	13	8304
14	312	14	1056	14	1728	14	2472	14	3192	14	3936	14	4656	14	5400	14	6144	14	6864	14	7608	14	8328
15	336	15	1080	15	1752	15	2496	15	3216	15	3960	15	4680	15	5424	15	6168	15	6888	15	7632	15	8352
16	360	16	1104	16	1776	16	2520	16	3240	16	3984	16	4704	16	5448	16	6192	16	6912	16	7656	16	8376
17	384	17	1128	17	1800	17	2544	17	3264	17	4008	17	4728	17	5472	17	6216	17	6936	17	7680	17	8400
18	408	18	1152	18	1824	18	2568	18	3288	18	4032	18	4752	18	5496	18	6240	18	6960	18	7704	18	8424
19	432	19	1176	19	1848	19	2592	19	3312	19	4056	19	4776	19	5520	19	6264	19	6984	19	7728	19	8448
20	456	20	1200	20	1872	20	2616	20	3336	20	4080	20	4800	20	5544	20	6288	20	7008	20	7752	20	8472
21	480	21	1224	21	1896	21	2640	21	3360	21	4104	21	4824	21	5568	21	6312	21	7032	21	7776	21	8496
22	504	22	1248	22	1920	22	2664	22	3384	22	4128	22	4848	22	5592	22	6336	22	7056	22	7800	22	8520
23	528	23	1272	23	1944	23	2688	23	3408	23	4152	23	4872	23	5616	23	6360	23	7080	23	7824	23	8544
24	552	24	1296	24	1968	24	2712	24	3432	24	4176	24	4896	24	5640	24	6384	24	7104	24	7848	24	8568
25	576	25	1320	25	1992	25	2736	25	3456	25	4200	25	4920	25	5664	25	6408	25	7128	25	7872	25	8592
26	600	26	1344	26	2016	26	2760	26	3480	26	4224	26	4944	26	5688	26	6432	26	7152	26	7896	26	8616
27	624	27	1368	27	2040	27	2784	27	3504	27	4248	27	4968	27	5712	27	6456	27	7176	27	7920	27	8640
28	648	28	1392	28	2064	28	2808	28	3528	28	4272	28	4992	28	5736	28	6480	28	7200	28	7944	28	8664
29	672			29	2088	29	2832	29	3552	29	4296	29	5016	29	5760	29	6504	29	7224	29	7968	29	8688
30	696			30	2112	30	2856	30	3576	30	4320	30	5040	30	5784	30	6528	30	7248	30	7992	30	8712
31	720			31	2136			31	3600			31	5064	31	5808			31	7272			31	8736

1.4.5 Note on Sample Times

There were two IES models, URI and Sea Data (hereafter SD). The SDs were produced by Sea Data Corp and designed from the URI model. The two models have different sampling cadences (Figure 4). Consider the 1800 sec (.5 hr) sampling interval. For comparison it is useful to assign the time 0.0 sec to the instant the previous sample was written to tape, 1800 sec would correspond to the instant the sample of interest is recorded. The relative durations and temporal postioning of samples are mapped in Figure 4. Note the locations at which a sample is located. The centers of the measuring interval for each sensor do not coincide except in the case of the URI model's temperature and pressure. In the URI model the travel time measurement is offset by 115 sec (middle of the duration of 24 pings at 10 sec intervals) from the temperature and pressure, located at 900 sec.

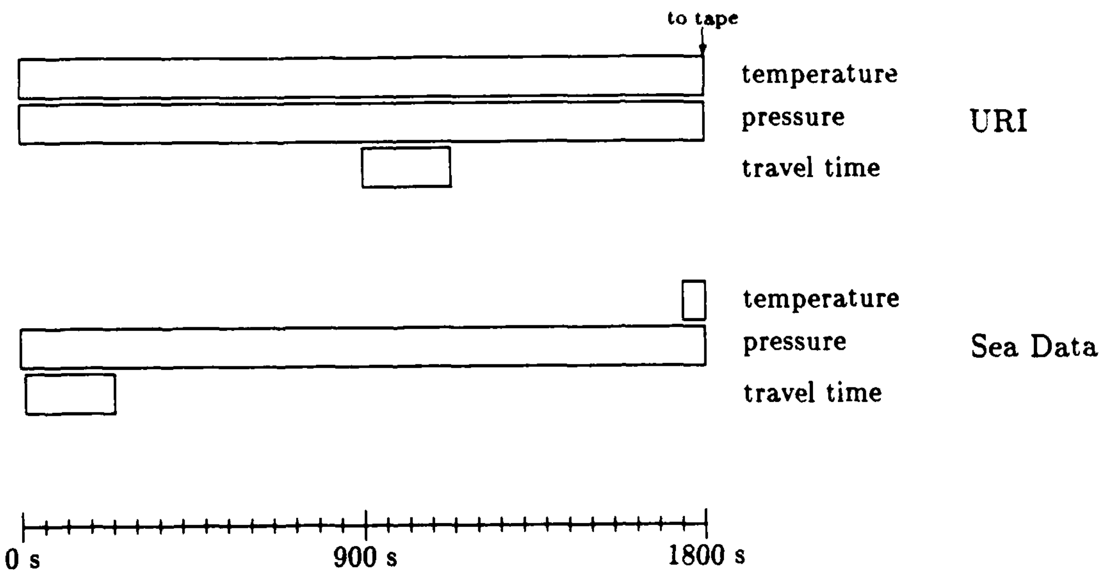


Figure 4: Sampling Sequences for URI and Sea Data Model IESs. The horizontal length and postion of the boxes represent the duration and relative temporal location of the sampling periods, respectively. Each tic mark represents a minute.

In the SD model the travel time is located at 115 + 11.25 sec, pressure will be at 900 sec, and temperature will be at 1771.875 sec (1800 - 56.25/2 sec). The temperature interval is also reduced to 56.25 sec (a sixty-forth of an hour). In the 11.25 sec before the first ping, the SD PIES does it's internal bookeeping and storage to tape. Original processing was done under the wrong understanding that the SD sampled in the same manner as the

URI model. The difference was discovered when the phases of tidal constituents showed a quarter hour discrepancy between models. In future work involving the SD instruments the MEMOD step will to be adjusted to use an average of the two temperature samples that nearly bracket the pressure interval (the one near the end of the .5 hr interval and the one just prior to the start) in the pressure sensor's temperature correction. The steps from RESPO onward were reprocessed with the correct time base. The correct times and tidal constants are listed in Tables 4-36.

1.5 Data Recovery

Tables 1 and 2 and Figure 2 summarize the data returns from each of the IESs. 34 of 37 instrument recoveries were successful (92%). Losses occurred at A1, H2, and I3. The IES89A1 failed to leave bottom and it was pressumed to have been stuck in the mud. PIES89H2_207 had a faulty release block and was unable to drop anchor. (PIES89H2_210 was deployed 15 km down a GEOSAT ground track from the old H2. It was sometimes refered to as H2′ to distinguish it's different location from the PIES89H2_207.) I3 did not respond to release signals and was not sampling when it was visited for recovery.

The data return from the IESs was successful except for the following cases: there was no data recorded at A2 due to a faulty travel time detector board on that IES and loss of a portion of I1 due to an insufficient length of tape. PIES89G2_213 was recovered on 10/8/89 when it time released, however it stopped logging data a month early for no apparent reason. PIES89G2 did provide data after it's intended original recover date of 5/29/89 and will provide valuable sensor performance information when compared with PIES90G2 deployed at the same location on 6/5/89. The two PIES's coverage overlapped for 100 days. The accuracy of the sensors and the nature of the exponential drift may be evaluated from that period. Overall there was good data in 88% of the records.

1.6 Special Processing for IES89B4_210

In the last 200 hr of IES89B4_210's 1474.5 hr deployment the sequence number was reset 18 times with no apparent explanation. The time base was short 4 hrs and it was assumed that records were lost in the area where the mysterious resetting occurred since the sequence number incremented correctly elsewhere. The resetting had no discernable pattern. Since the record was particularly uneventful (small variance) it was decided to simply add records

Figure 5: Cassette Tape Bit Layout

Normal Storage

Track	Bits of Seq #				Bits of τs																
1	1	5	9	13	*1*	*5*	*9*	*13*	4	8	12	*3*	*7*	*11*	2	6	10	...			
2	2	6	10	14	*2*	*6*	*10*	1	5	9	13	*4*	*8*	*12*	3	7	11	...			
3	3	7	11	15	*3*	*7*	*11*	2	6	10	*1*	*5*	*9*	*13*	4	8	12	...			
4	4	8	12	16	*4*	*8*	*12*	3	7	11	*2*	*6*	*10*	1	5	9	13	...			

Missing Tracks

Track	Bits of Seq #				Bits of τs														
1	1	5	9	13	*1*	*5*	*9*	*13*	4	8	12	*3*	*7*	*11*	2	6	10	...	
2	2	6	10	14	*2*	*6*	*10*	1	5	9	13	*4*	*8*	*12*	3	7	11	...	
3	lost																		
4	lost																		

at eight locations of maximum sequence number. The inserted values were taken equal to the value before the corresponding reset.

1.7 Special Processing for IES89G1_207

G1 is notable for two reasons: it was out for 20 months (10/24/87 – 5/27/89, deployed during EN169) and secondly it was necessary to reconstruct the record from only two tracks of the four track data storage cassette. The bit map (figure 5) shows how, given only two tracks, the remaining bits of alternating travel time words (τs) may be bit-wise combined to form a complete word. The italicized numbers denote the remaining bits for the first and the third τ. The first italicized group contains bits 1,2,5,6,9,10, and 13, the second set of italicized bit postions from the third τ contains bits 3,4,7,8,11, and 12. Together they comprise 13 bits of a whole travel time word. The method was verified on reccords for which all tracks worked, by blanking out tracks 3 and 4 and comparing the reconstituted records with results of the usual processing. For an IES with only small scatter in τ the agreement is excellent. However for G1 the method proved difficult to implement due to an excessively noisy record resulting from an overly sensitve echo detector. In order to get better sampling size, the output record was combined into three-hourly increments rather than half-hourly.

1.8 Special Processing for PIES89I5_207

PIES I5 had a defective tape recorder, and many read errors were encounted in the SDR step. The sequence number and measurement records were excessively noisy. Special care was taken to restore the sequence number and thus the time base. Although the records were restored well it is worth noting that spikes (as identified by the DESPIKE code) composed nearly 30% of the records.

2 Individual Site and Record Information Tables

The tables that follow provide information about the location, dates, and basic statistics of the data records. Each table documents a single instrument deployment. Some instruments were recovered twice, once during cruise OC207 and again during OC210 (H7, B4, and B5) and thus two tables will be found for these sites. The recovery cruise number will be suffixed to the deployment specification to make the distinction clear (For example IES89B4_207 vs IES89B4_210).

General site information, such as position, bottom depth, and launch and recovery times, is given first. Subsequently, details about the travel time, bottom pressure, temperature and thermocline depth records plotted in Sections 3–5 are tabulated. Tables supply the times associated with the first and last data point of each plot. All yearhours are referenced to January 1, 1989 at 0000 GMT. Measurements made during the calendar year prior to the reference date are given as negative yearhours.

The first order statistics (minimum, maximum, mean, and standard deviation) are tabulated for the half-hourly and six-hourly low-passed records (40 HRLP) for each variable of standard IES and PIESs.

Note the absolute travel time displayed should not be interpreted as the round trip travel time. For storage economy only the 13 least significant bits are recorded and wrapping occurs. This has the advantage that full-scale resolution of the variation is ~200 msec rather than the full absolute time (~6 sec). The variation in travel time is what is utilized. After calibration to thermocline depth all records are on a common basis.

Site and Record Information for
IES89B1

Serial Number: 41
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°45.10 N DEPTH: 1975 m
74°28.00 W

	DATE	GMT	CRUISE
LAUNCH:	May 28, 1988	0612	Oc200
RELEASE:	Jun 10, 1989	0855	Oc207

TRAVEL TIME RECORDS
Fig. 6.1 and 10.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 28, 1988	070119	-5224.978
LAST DATA POINT:	Jun 10, 1989	050119	3845.022

Number of Points: 18141
Sampling Interval: 0.5 hr

Minimum τ = 0.22409 s Mean = 0.21805 s
Maximum τ = 0.21166 s Standard Deviation = 0.00234 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.1

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 4408 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 29, 1988	0600	-5202
LAST DATA POINT:	Jun 9, 1989	0600	3822

Number of Points: 1505
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 162.9 m Mean = 265.4 m
Maximum Z_{12} = 367.4 m Standard Deviation = 42.7 m

Table 4: **IES89B1**

Site and Record Information for
IES89B2

Serial Number: 78
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°36.92 N DEPTH: 2650 m
74°14.20 W

	DATE	GMT	CRUISE
LAUNCH:	May 29, 1988	2353	Oc200
RELEASE:	Aug 10, 1989	0317	Oc210

TRAVEL TIME RECORDS
Fig. 6.2 and 10.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 30, 1988	003224	-5183.460
LAST DATA POINT:	Aug 10, 1989	023224	5306.540

Number of Points: 20981
Sampling Interval: 0.5 hr

Minimum τ = 0.34338s Mean = 0.35087 s
Maximum τ = 0.36395 s Standard Deviation = 0.00382 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.1

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 7103.7 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 31, 1988	0000	-5160
LAST DATA POINT:	Aug 9, 1989	0600	5286

Number of Points: 1742
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 162.9 m Mean = 265.4 m
Maximum Z_{12} = 367.4 m Standard Deviation = 71.1 m

Table 5: **IES89B2**

Site and Record Information for
IES89B3

Serial Number: 77
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°28.96 N   DEPTH: 2985 m
74°02.63 W

	DATE	GMT	CRUISE
LAUNCH:	May 29, 1988	2038	Oc200
RELEASE:	Aug 10, 1989	0737	Oc210

TRAVEL TIME RECORDS
Fig. 6.3 and 10.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 29, 1988	213242	-5186.455
LAST DATA POINT:	Aug 10, 1989	073242	5311.545

Number of Points: 20997
Sampling Interval: 0.5 hr

Minimum τ = 0.37978 s   Mean = 0.38553 s
Maximum τ = 0.40300 s   Standard Deviation = 0.00271 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.1

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 7938.7 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 30, 1988	1800	-5166
LAST DATA POINT:	Aug 9, 1989	0600	5286

Number of Points: 1743
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 294.5 m   Mean = 614.0 m
Maximum Z_{12} = 708.3 m   Standard Deviation = 50.3 m

Table 6: **IES89B3**

Site and Record Information for IES89B4_207

Serial Number: 76
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°20.70 N 73°51.00 W DEPTH: 3325 m

	DATE	GMT	CRUISE
LAUNCH:	May 29, 1988	1530	Oc200
RELEASE:	Jun 11, 1989	0344	Oc207

TRAVEL TIME RECORDS
Fig. 6.4 and 10.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 29, 1988	163217	-5191.462
LAST DATA POINT:	Jun 11, 1989	033217	3867.538

Number of Points: 18119
Sampling Interval: 0.5 hr

Minimum τ = 0.04364 s Mean = 0.04902 s
Maximum τ = 0.05792 s Standard Deviation = 0.00174 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.1

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 1693.7 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 30, 1988	1800	-5166
LAST DATA POINT:	Jun 10, 1989	0600	3846

Number of Points: 1503
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 603.6 m Mean = 762.5 m
Maximum Z_{12} = 851.4 m Standard Deviation = 32.1 m

Table 7: **IES89B4_207**

Site and Record Information for
IES89B4_210

Serial Number: 79
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°20.80 N DEPTH: 3325 m
73°50.50 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 11, 1989	0538	Oc207
RELEASE:	Aug 11, 1989	1725	Oc210

TRAVEL TIME RECORDS
Fig. 6.5 and 10.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1989	063112	3870.520
LAST DATA POINT:	Aug 11, 1989	170112	5345.020

Number of Points: 2950
Sampling Interval: 0.5 hr

Minimum τ = 0.05094 s Mean = 0.05335 s
Maximum τ = 0.05719 s Standard Deviation = 0.01063 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.1

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 1720.9 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1989	0600	3894
LAST DATA POINT:	Aug 10, 1989	1800	5322

Number of Points: 239
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 647.2 m Mean = 708.2 m
Maximum Z_{12} = 738.8 m Standard Deviation = 18.3 m

Table 8: **IES89B4_210**

Site and Record Information for
IES89B5_207

Serial Number: 75
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°12.06 N   DEPTH: 3620 m
73°40.01 W

	DATE	GMT	CRUISE
LAUNCH:	May 29, 1988	1148	Oc200
RELEASE:	Jun 10, 1989	2153	Oc207

TRAVEL TIME RECORDS
Fig. 6.6 and 10.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 29, 1988	130224	-5194.960
LAST DATA POINT:	Jun 10, 1989	213224	3861.540

Number of Points: 18114
Sampling Interval: 0.5 hr

Minimum τ = 0.06632 s   Mean = 0.05719 s
Maximum τ = 0.04909 s   Standard Deviation = 0.00217 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.1

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 1900.6 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 30, 1988	1200	-5172
LAST DATA POINT:	Jun 10, 1989	0000	3840

Number of Points: 1503
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 652.9 m   Mean = 814.0 m
Maximum Z_{12} = 953.1 m   Standard Deviation = 39.8 m

Table 9: **IES89B5_207**

Site and Record Information for
IES89B5_210

Serial Number: 80
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°12.04 N 73°39.95 W   DEPTH: 3773 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 11, 1989	2343	Oc207
RELEASE:	Aug 11, 1989	1318	Oc210

TRAVEL TIME RECORDS
Fig. 6.7 and 10.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1989	010116	3865.021
LAST DATA POINT:	Aug 11, 1989	130116	5341.021

Number of Points: 2953
Sampling Interval: 0.5 hr

Minimum τ = 0.05100 s   Mean = 0.05391 s
Maximum τ = 0.05630 s   Standard Deviation = 0.00106 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.1

Z_{12} Conversion equation: $Z_{12} = -19000 ms^{-1} \cdot \tau_d + B$
where B= 1796.4 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1989	0000	3888
LAST DATA POINT:	Aug 10, 1989	1200	5316

Number of Points: 239
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 739.1 m   Mean = 772.5 m
Maximum Z_{12} = 816.0 m   Standard Deviation = 19.1 m

Table 10: **IES89B5_210**

Site and Record Information for
IES89C1

Serial Number: 40
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 36°04.67 N 73°56.90 W DEPTH: 3130 m

	DATE	GMT	CRUISE
LAUNCH:	May 31, 1988	0434	Oc200
RELEASE:	Jun 12, 1989	0915	Oc207

TRAVEL TIME RECORDS
Fig. 6.8 and 10.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 31, 1988	053155	-5154.468
LAST DATA POINT:	Jun 12, 1989	085906	3896.985

Number of Points: 18104
Sampling Interval: 0.5 hr

Minimum τ = 0.18336 s   Mean = 0.19284 s
Maximum τ = 0.20452 s   Standard Deviation = 0.00499 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.2

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 4035.3 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 1, 1988	0600	-5130
LAST DATA POINT:	Jun 11, 1989	1200	3876

Number of Points: 1502
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 167.6 m   Mean = 371.9 m
Maximum Z_{12} = 535.1 m   Standard Deviation = 93.965

Table 11: **IES89C1**

Site and Record Information for
IES89C2

Serial Number: 46
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 35°46.20 N DEPTH: 3450 m
73°32.90 W

	DATE	GMT	CRUISE
LAUNCH:	May 31, 1988	0915	Oc200
RELEASE:	Aug 11, 1989	0724	Oc210

TRAVEL TIME RECORDS
Fig. 6.9 and 10.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 31, 1988	101655	-5149.718
LAST DATA POINT:	Aug 11, 1989	071308	5335.219

Number of Points: 20971
Sampling Interval: 0.5 hr

Minimum τ = 0.18968 s   Mean = 0.19567 s
Maximum τ = 0.20892 s   Standard Deviation = 0.00287 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.2

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 4413.6 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 1, 1988	1200	-5124
LAST DATA POINT:	Aug 10, 1989	0600	5310

Number of Points: 1740
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 477.2 m   Mean = 696.5 m
Maximum Z_{12} = 796.2 m   Standard Deviation = 53.3 m

Table 12: **IES89C2**

Site and Record Information for IES89F1

Serial Number: 47
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 37°56.94 N 69°57.98 W DEPTH: 3980 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 12, 1988	0138	OC200
RELEASE:	Jun 5, 1989	0721	OC207

TRAVEL TIME RECORDS
Fig. 6.10 and 10.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1988	023155	-4869.468
LAST DATA POINT:	Jun 5, 1989	065841	3726.978

Number of Points: 17194
Sampling Interval: 0.5 hr

Minimum τ = 0.38300 s   Mean = 0.40087 s
Maximum τ = 0.41211 s   Standard Deviation = 0.00655 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.3

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 7930 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1988	0000	-4848
LAST DATA POINT:	Jun 04, 1989	0600	3702

Number of Points: 1426
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 123.1 m   Mean = 314.3 m
Maximum Z_{12} = 636.1 m   Standard Deviation = 123.6 m

Table 13: **IES89F1**

Site and Record Information for
IES89F2

Serial Number: 58
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 37°24.40 N DEPTH: 4245 m
69°46.50 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 14, 1988	0150	Oc200
RELEASE:	Aug 14, 1989	0205	Oc210

TRAVEL TIME RECORDS
Fig. 6.11 and 10.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 14, 1988	024644	-4821.221
LAST DATA POINT:	Aug 14, 1989	014644	5401.779

Number of Points: 20447
Sampling Interval: 0.5 hr

Minimum τ = 0.06965 s Mean = 0.04475 s
Maximum τ = 0.03396 s Standard Deviation = 0.00714 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.3

Z_{12} Conversion equation: $Z_{12} = -19000 ms^{-1} \cdot \tau_d + B$
where B= 1499 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 15, 1988	0000	-4800
LAST DATA POINT:	Aug 13, 1989	0000	5376

Number of Points: 1697
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 191.9 m Mean = 649.4 m
Maximum Z_{12} = 841.3 m Standard Deviation = 134.9 m

Table 14: **IES89F2**

Site and Record Information for
IES89F3

Serial Number: 61
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 36°42.10 N DEPTH: 4400 m
69°33.60 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 14, 1988	0609	Oc200
RELEASE:	Aug 14, 1989	0903	Oc210

TRAVEL TIME RECORDS
Fig. 6.12 and 10.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 14, 1988	070155	-4816.968
LAST DATA POINT:	Aug 14, 1989	082942	5408.495

Number of Points: 20452
Sampling Interval: 0.5 hr

Minimum τ = 0.26175 s Mean = 0.26973 s
Maximum τ = 0.28915 s Standard Deviation = 0.00297 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.3

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 5962 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 15, 1988	0600	-4794
LAST DATA POINT:	Aug 13, 1989	0600	5382

Number of Points: 1697
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 603.1 m Mean = 837.3 m
Maximum Z_{12} = 976.3 m Standard Deviation = 56.1 m

Table 15: **IES89F3**

Site and Record Information for IES89G1

Serial Number: 39
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 38°37.64 N 69°25.28 W DEPTH: 3362 m

	DATE	GMT	CRUISE
LAUNCH:	Oct 24, 1987	2022	En169
RELEASE:	May 27, 1989	0649	Oc207

TRAVEL TIME RECORDS

Fig. 6.13 and 10.4

	DATE	GMT	YEARHOUR
1st DATA POINT:	Oct 25, 1987	094424	-10406.26
LAST DATA POINT:	May 26, 1989	184424	3498.740

Number of Points: 4643
Sampling Interval: 3 hr

Minimum τ = 0.07881 s Mean = 0.08956 s
Maximum τ = 0.09476 s Standard Deviation = 0.03337 s

40HRLP THERMOCLINE DEPTH RECORDS

Fig. 13.4

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 1888 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Oct 26, 19887	1200	-10380
LAST DATA POINT:	May 25, 1989	1800	3474

Number of Points: 2310
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 92.8 m Mean = 186.4 m
Maximum Z_{12} = 388.0 m Standard Deviation = 63.1 m

Table 16: **IES89G1**

Site and Record Information for
PIES89G2

Serial Number: 70
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 33808

POSITION: 37°47.52 N DEPTH: 4060 m
69°24.33 W

	DATE	GMT	CRUISE
LAUNCH:	May 27, 1988	0115	Oc200
TIMED RELEASE:	Oct 8, 1989	1500	Oc213

TRAVEL TIME RECORDS
Fig. 6.14 and 10.4

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 27, 1988	023155	-5253.468
LAST DATA POINT:	Sep 12, 1989	120831	6132.142

Number of Points: 22772
Sampling Interval: 0.5 hr

Minimum τ = 0.19591 s Mean = 0.21319 s
Maximum τ = 0.22733 s Standard Deviation = 0.00787 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.4

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 4372 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 28, 1988	0000	-5232
LAST DATA POINT:	Sep 12, 1989	1200	6108

Number of Points: 1891
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 68.8 m Mean = 321.4 m
Maximum Z_{12} = 639.3 m Standard Deviation = 149.0 m

Table 17: **PIES89G2**

PIES89G2 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 27, 1988	024449	-5253.253
LAST DATA POINT:	Sep 13, 1989	122125	6132.357

Number of Points: 22772
Sampling Interval: 0.5 hrs

Minimum = 4141.68 dbar   Mean = 4142.44 dbar
Maximum = 4143.29 dbar   Standard Deviation = 0.32777 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.1 and 11.1

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= $P_3 + P_4 t$

where t = Time of sample in hours, starting with t = 13.0hrs for the first data point

$P_3 =$ 0.094320 dbar

$P_4 =$ -1.6555×10^{-5} dbar hr^{-1}

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42965	.09710	.09237	.02186	.08269	.06432	.02720	.01410
G°:	352.74	333.93	20.41	22.34	177.35	182.20	178.12	180.12

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 27, 1988	144449	-5241.253
LAST DATA POINT:	Sep 13, 1989	122125	6132.357

Number of Points: 22748
Sampling Interval: 0.5 hrs

Minimum = −0.1443 dbar   Mean = 0.0000 dbar
Maximum = 0.1387 dbar   Standard Deviation = 0.0399 dbar

PIES89G2 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 28, 1988	1200	-5220
LAST DATA POINT:	Sep 12, 1989	1200	6108

Number of Points: 1889
Sampling Interval: 6.0 hrs

Minimum = −0.1203 dbar Mean = 0.0000 dbar
Maximum = 0.1177 dbar Standard Deviation = 0.037 dbar

TEMPERATURE RECORDS

Fig. 8.1 and 12.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 27, 1988	025920	−5253.011
LAST DATA POINT:	Sep 13, 1989	123556	6132.599

Number of Points: 22772
Sampling Interval: 0.5 hrs

Minimum = 2.510°C Mean = 2.557°C
Maximum = 2.610°C Standard Deviation = 0.0097°C

40HRLP TEMPERATURE RECORDS

Fig. 15.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 28, 1988	0000	-5232
LAST DATA POINT:	Sep 12, 1989	1200	6108

Number of Points: 1891
Sampling Interval: 6.0 hrs

Minimum = 2.512 °C Mean = 2.557 °C
Maximum = 2.602 °C Standard Deviation = 0.009 °C

Site and Record Information for
PIES89G3

Serial Number: 69
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 33816

POSITION: 37°17.40 N 69°14.53 W DEPTH: 4358 m

	DATE	GMT	CRUISE
LAUNCH:	May 26, 1988	1452	OC200
RELEASE:	May 29, 1989	0135	OC207

TRAVEL TIME RECORDS
Fig. 6.15 and 10.4

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 26, 1988	160217	-5263.962
LAST DATA POINT:	May 29, 1989	013217	3553.538

Number of Points: 17636
Sampling Interval: 0.5 hr

Minimum τ = 0.18767 s Mean = 0.19746 s
Maximum τ = 0.22405 s Standard Deviation = 0.00555 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.4

Z_{12} Conversion equation: $Z_{12} = -19000 ms^{-1} \cdot \tau_d + B$
where B= 4414 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 27, 1988	1800	-5238
LAST DATA POINT:	May 28, 1989	0000	3528

Number of Points: 1462
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 199.6 m Mean = 662.4 m
Maximum Z_{12} = 828.7 m Standard Deviation = 104.3 m

Table 18: **PIES89G3**

PIES89G3 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 26, 1988	161510	-5263.747
LAST DATA POINT:	May 29, 1989	014510	3553.753

Number of Points: 17636
Sampling Interval: 0.5 hrs

Minimum = 4456.35 dbar Mean = 4457.11 dbar
Maximum = 4457.92 dbar Standard Deviation = 0.32336 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.2 and 11.1

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= 0.0

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42744	.09658	.09287	.02206	.08179	.06424	.02695	.01398
G°:	352.90	334.27	20.63	22.59	178.01	182.75	178.80	180.45

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 27, 1988	041510	-5251.747
LAST DATA POINT:	May 29, 1989	014510	3553.753

Number of Points: 17612
Sampling Interval: 0.5 hrs

Minimum = -0.1418 dbar Mean = 0.0001 dbar
Maximum = 0.1794 dbar Standard Deviation = 0.0465 dbar

PIES89G3 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 28, 1988	0600	-5226
LAST DATA POINT:	May 28, 1989	0000	3528

Number of Points: 1460
Sampling Interval: 6.0 hrs

Minimum = -0.1207 dbar   Mean = 0.0001 dbar
Maximum = 0.1537 dbar   Standard Deviation = 0.0440 dbar

TEMPERATURE RECORDS

Fig. 8.2 and 12.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 26, 1988	162942	-5263.505
LAST DATA POINT:	May 29, 1989	015942	3553.995

Number of Points: 17636
Sampling Interval: 0.5 hrs

Minimum = 2.576°C   Mean = 2.622°C
Maximum = 2.685°C   Standard Deviation = 0.0105°C

40HRLP TEMPERATURE RECORDS

Fig. 15.1

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 27, 1988	1800	-5238
LAST DATA POINT:	May 28, 1989	0000	3528

Number of Points: 1462
Sampling Interval: 6.0 hrs

Minimum = 2.590 °C   Mean = 2.622 °C
Maximum = 2.672 °C   Standard Deviation = 0.010 °C

Site and Record Information for
IES89G4

Serial Number: 57
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 36°33.19 N DEPTH: 4675 m
68°40.49 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 6, 1988	0142	Oc200
RELEASE:	Jun 17, 1989	0905	Oc207

TRAVEL TIME RECORDS
Fig. 6.16 and 10.4

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 6, 1988	030155	-5012.968
LAST DATA POINT:	Jun 17 1989	082450	4016.414

Number of Points: 18060
Sampling Interval: 0.5 hr

Minimum τ = 0.23441 s Mean = 0.24419 s
Maximum τ = 0.25376 s Standard Deviation = 0.27461 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.4

Z_{12} Conversion equation: $Z_{12} = -19000 ms^{-1} \cdot \tau_d + B$
where B= 5480 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 07, 1988	0000	-4992
LAST DATA POINT:	Jun 16, 1989	0600	3990

Number of Points: 1498
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 683.2 m Mean = 850.6 m
Maximum Z_{12} =1022.2 m Standard Deviation = 51.382

Table 19: **IES89G4**

Site and Record Information for IES89H1

Serial Number: 30
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 39°00.00 N 68°40.32 W DEPTH: 3255 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 11, 1988	0116	Oc200
RELEASE:	Jun 2, 1989	0332	Oc207

TRAVEL TIME RECORDS
Fig. 6.17 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	021655	-4893.718
LAST DATA POINT:	Jun 2, 1989	031229	3651.208

Number of Points: 17091
Sampling Interval: 0.5 hr

Minimum τ = 0.32683 s Mean = 0.34289 s
Maximum τ = 0.35020 s Standard Deviation = 0.00521 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.5

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 6722 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1988	0000	-4872
LAST DATA POINT:	Jun 1, 1989	0600	3630

Number of Points: 1418
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 89.4 m Mean = 207.4 m
Maximum Z_{12} = 495.4 m Standard Deviation = 98.6 m

Table 20: **IES89H1**

Site and Record Information for
IES89H2

Serial Number: 39
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 38°25.80 N DEPTH: 3580 m
69°02.00 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 5, 1989	0056	Oc207
RELEASE:	Aug 15, 1989	0922	Oc210

TRAVEL TIME RECORDS
Fig. 6.18 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 5, 1989	023152	3722.531
LAST DATA POINT:	Aug 15, 1989	090152	5433.031

Number of Points: 3422
Sampling Interval: 0.5 hr

Minimum τ = 0.38293 s Mean = 0.39008 s
Maximum τ = 0.39440 s Standard Deviation = 0.00272 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.5

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 7593 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 6, 1989	0000	3744
LAST DATA POINT:	Aug 14, 1989	1200	5412

Number of Points: 279
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 112.5 m Mean = 180.6 m
Maximum Z_{12} = 296.3 m Standard Deviation = 50.3 m

Table 21: **IES89H2_210**

Site and Record Information for
PIES89H3

Serial Number: 65
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 28197

POSITION: 38°10.10 N DEPTH: 4030 m
68°43.30 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 11, 1988	1539	Oc200
RELEASE:	Aug 15, 1989	0538	Oc210

TRAVEL TIME RECORDS
Fig. 6.19 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	163217	-4879.462
LAST DATA POINT:	Aug 15, 1989	053217	5429.538

Number of Points: 20619
Sampling Interval: 0.5 hr

Minimum τ = 0.14899 s Mean = 0.16890 s
Maximum τ = 0.17573 s Standard Deviation = 0.00364 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.5

Z_{12} Conversion equation: $Z_{12} = -19000 ms^{-1} \cdot \tau_d + B$
where B= 3410 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1988	1800	-4854
LAST DATA POINT:	Aug 14, 1989	0600	5406

Number of Points: 1711
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 89.7 m Mean = 200.9 m
Maximum Z_{12} = 557.5 m Standard Deviation = 68.5 m

Table 22: **PIES89H3**

PIES89H3 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	164509	-4879.247
LAST DATA POINT:	Aug 15, 1989	054509	5429.753

Number of Points: 20619
Sampling Interval: 0.5 hrs

Minimum = 4102.14 dbar — Mean = 4102.96 dbar
Maximum = 4103.79 dbar — Standard Deviation = 0.32310 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.3 and 11.2

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= $P_1 exp(-P_2 t) + P_3$

where t = Time of sample in hours, starting with t = 13.0hrs for the first data point

$P_1 =$ -0.26320 dbar

$P_2 =$ 0.001902 hr^{-1}

$P_3 =$ 0.013198 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42613	.09661	.09351	.02227	.08131	.06337	.02676	.01384
G°:	352.76	333.84	20.62	22.50	176.43	181.21	177.24	178.76

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1988	044509	-4867.247
LAST DATA POINT:	Aug 15, 1989	054509	5429.753

Number of Points: 20595
Sampling Interval: 0.5 hrs

Minimum = -0.1379 dbar — Mean = 0.0000 dbar
Maximum = 0.1412 dbar — Standard Deviation = 0.0401 dbar

PIES89H3 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 13, 1988	0600	-4842
LAST DATA POINT:	Aug 14, 1989	0600	5406

Number of Points: 1709
Sampling Interval: 6.0 hrs

Minimum = -0.1066 dbar Mean = 0.0002 dbar
Maximum = 0.1207 dbar Standard Deviation = 0.0375 dbar

TEMPERATURE RECORDS

Fig. 8.3 and 12.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	165941	-4879.005
LAST DATA POINT:	Aug 15, 1989	055941	5429.995

Number of Points: 20619
Sampling Interval: 0.5 hrs

Minimum = 2.231°C Mean = 2.260°C
Maximum = 2.325°C Standard Deviation = 0.0096°C

40HRLP TEMPERATURE RECORDS

Fig. 15.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 12, 1988	1800	-4854
LAST DATA POINT:	Aug 14, 1989	0600	5406

Number of Points: 1711
Sampling Interval: 6.0 hrs

Minimum = 2.234 °C Mean = 2.260 °C
Maximum = 2.298 °C Standard Deviation = 0.009 °C

Site and Record Information for
PIES89H4

Serial Number: H4
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 19327

POSITION: 37°39.80 N DEPTH: 4445 m
68°35.40 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 14, 1988	1716	Oc200
RELEASE:	Aug 15, 1989	0121	Oc210

TRAVEL TIME RECORDS
Fig. 6.20 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 14, 1988	181626	-4805.726
LAST DATA POINT:	Aug 15, 1989	004626	5424.774

Number of Points: 20462
Sampling Interval: 0.5 hr

Minimum τ = 0.30626 s Mean = 0.32602 s
Maximum τ = 0.34220 s Standard Deviation = 0.01027 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.5

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 6589 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 15, 1988	1800	-4782
LAST DATA POINT:	Aug 14, 1989	0000	5400

Number of Points: 1698
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 105.5 m Mean = 395.5 m
Maximum Z_{12} = 748.5 m Standard Deviation = 194.7 m

Table 23: **PIES89H4**

PIES89H4 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.4

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 14, 1988	181431	-4805.758
LAST DATA POINT:	Aug 15, 1989	004431	5424.742

Number of Points: 20462
Sampling Interval: 0.5 hrs

Minimum = 4542.17 dbar   Mean = 4542.99 dbar
Maximum = 4543.85 dbar   Standard Deviation = 0.32932 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.4 and 11.2

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= $P_3 + P_4 t$

where t = Time of sample in hours, starting with t = 13.0hrs for the first data point

$P_3 =$ −0.129100 dbar

$P_4 =$ 0.000025 dbar hr^{-1}

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42651	.09628	.09292	.02207	.08058	.06280	.02647	.01394
G^o:	352.87	334.01	20.57	22.49	177.09	182.01	177.82	180.32

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 15, 1988	061431	-4793.758
LAST DATA POINT:	Aug 15, 1989	004431	5424.742

Number of Points: 20438
Sampling Interval: 0.5 hrs

Minimum = -0.1610 dbar   Mean = 0.0000 dbar
Maximum = 0.1476 dbar   Standard Deviation = 0.0461 dbar

PIES89H4 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 16, 1988	0600	—4770
LAST DATA POINT:	Aug 14, 1989	0000	5400

Number of Points: 1696
Sampling Interval: 6.0 hrs

Minimum = -0.1283 dbar   Mean = -0.0002 dbar
Maximum = 0.1343 dbar   Standard Deviation = 0.0439 dbar

TEMPERATURE RECORDS

Fig. 8.4 and 12.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 14, 1988	181431	-4805.758
LAST DATA POINT:	Aug 15, 1989	004431	5424.742

Number of Points: 20462
Sampling Interval: 0.5 hrs

Minimum = 2.353°C   Mean = 2.412°C
Maximum = 2.500°C   Standard Deviation = 0.016°C

40HRLP TEMPERATURE RECORDS

Fig. 15.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 18, 1988	0000	-4728
LAST DATA POINT:	Aug 14, 1989	0000	5400

Number of Points: 1698
Sampling Interval: 6.0 hrs

Minimum = 2.354 °C   Mean = 2.412 °C
Maximum = 2.480 °C   Standard Deviation = 0.015 °C

Site and Record Information for
PIES89H5

Serial Number: 71
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 31724

POSITION: 37°10.60 N DEPTH: 4790 m
68°17.00 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 7, 1988	2102	Oc200
RELEASE:	Aug 14, 1989	1738	Oc210

TRAVEL TIME RECORDS
Fig. 6.21 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 7, 1988	220220	-4969.961
LAST DATA POINT:	Aug 14, 1989	173220	5417.539

Number of Points: 20776
Sampling Interval: 0.5 hr

Minimum τ = 0.39052 s Mean = 0.40443 s
Maximum τ = 0.42990 s Standard Deviation = 0.01309 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.5

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 8265 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	0000	-4944
LAST DATA POINT:	Aug 13, 1989	1800	5394

Number of Points: 1724
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 128.8 m Mean = 581.3 m
Maximum Z_{12} = 832.3 m Standard Deviation = 246.6 m

Table 24: **PIES89H5**

PIES89H5 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 7, 1988	221512	-4969.743
LAST DATA POINT:	Aug 14, 1989	174512	5417.753

Number of Points: 20776
Sampling Interval: 0.5 hrs

Minimum = 4935.22 dbar   Mean = 4936.20 dbar
Maximum = 4937.07 dbar   Standard Deviation = 0.33113 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.5 and 11.2

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= $P_1 exp(-P_2 t) + P_3$

where t = Time of sample in hours, starting with t = 13.0hrs for the first data point

$P_1 =$ -0.47326 dbar

$P_2 =$ 0.002600 hr^{-1}

$P_3 =$ 0.017783 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42418	..09586	.09332	.02221	.07929	.06266	.02609	.01386
$G°$:	353.25	334.09	21.43	23.38	177.37	183.08	178.27	180.70

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 8 , 1988	101512	-4957.743
LAST DATA POINT:	Aug 14, 1989	174512	5417.753

Number of Points: 20752
Sampling Interval: 0.5 hrs

Minimum = -0.2051 dbar   Mean = 0.0001 dbar
Maximum = 0.1749 dbar   Standard Deviation = 0.0764 dbar

PIES89H5 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	1200	−4932
LAST DATA POINT:	Aug 13, 1989	1800	5394

Number of Points: 1722
Sampling Interval: 6.0 hrs

Minimum = -0.1928 dbar   Mean = 0.0001 dbar
Maximum = 0.1536 dbar   Standard Deviation = 0.0752 dbar

TEMPERATURE RECORDS

Fig. 8.4 and 12.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 7, 1988	222944	−4969.504
LAST DATA POINT:	Aug 14, 1989	175944	5417.996

Number of Points: 20776
Sampling Interval: 0.5 hrs

Minimum = 2.386°C   Mean = 2.461°C
Maximum = 2.520°C   Standard Deviation = 0.016°C

40HRLP TEMPERATURE RECORDS

Fig. 15.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	0000	−4944
LAST DATA POINT:	Aug 13, 1989	1800	5394

Number of Points: 1724
Sampling Interval: 6.0 hrs

Minimum = 2.398 °C   Mean = 2.461 °C
Maximum = 2.502 °C   Standard Deviation = 0.015 °C

Site and Record Information for PIES89H6

Serial Number: 67
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 33824

POSITION: 36°40.45 N 68°15.64 W DEPTH: 4883 m

	DATE	GMT	CRUISE
LAUNCH:	May 22, 1988	2259	Oc200
RELEASE:	Jun 3, 1989	2237	Oc207

TRAVEL TIME RECORDS

Fig. 6.22 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 23, 1988	000155	-5351.968
LAST DATA POINT:	Jun 3, 1989	223430	3694.575

Number of Points: 18094
Sampling Interval: 0.5 hr

Minimum τ = 0.05112 s Mean = 0.06132 s
Maximum τ = 0.08815 s Standard Deviation = 0.00474 s

40HRLP THERMOCLINE DEPTH RECORDS

Fig.13.5

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 1995 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 24, 1988	0000	-5328
LAST DATA POINT:	Jun 3, 1989	0000	3672

Number of Points: 1501
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 341.2 m Mean = 830.6 m
Maximum Z_{12} = 1011.6 m Standard Deviation = 88.6 m

Table 25: **PIES89H6**

PIES89H6 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.6

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 23, 1988	001449	-5351.753
LAST DATA POINT:	Jun 3, 1989	224724	3694.790

Number of Points: 18094
Sampling Interval: 0.5 hrs

Minimum = 4988.02 dbar　　Mean = 4988.78 dbar
Maximum = 4989.61 dbar　　Standard Deviation = 0.32203 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.6 and 11.2

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= 0.0

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42146	..09483	.09293	.02212	.07894	.06172	.02598	.01352
$G°$:	353.79	334.82	21.50	23.41	178.50	183.52	179.15	182.55

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 23, 1988	121449	-5339.753
LAST DATA POINT:	Jun 3, 1989	224724	3694.790

Number of Points: 18070
Sampling Interval: 0.5 hrs

Minimum = -0.1593 dbar　　Mean = -0.0001 dbar
Maximum = 0.3433 dbar　　Standard Deviation = 0.0663 dbar

PIES89H6 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 24, 1988	1200	-5316
LAST DATA POINT:	Jun 3, 1989	0000	3672

Number of Points: 1499
Sampling Interval: 6.0 hrs

Minimum = -0.1268 dbar   Mean = -0.0004 dbar
Maximum = 0.2754 dbar   Standard Deviation = 0.0641 dbar

TEMPERATURE RECORDS

Fig. 8.6 and 12.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 23, 1988	002921	-5352.511
LAST DATA POINT:	Jun 3, 1989	230156	3695.032

Number of Points: 18094
Sampling Interval: 0.5 hrs

Minimum = 2.464°C   Mean = 2.520°C
Maximum = 2.565°C   Standard Deviation = 0.0106°C

40HRLP TEMPERATURE RECORDS

Fig. 15.2

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 24, 1988	0000	-5328
LAST DATA POINT:	Jun 3, 1989	0000	3672

Number of Points: 1501
Sampling Interval: 6.0 hrs

Minimum = 2.466 °C   Mean = 2.520 °C
Maximum = 2.543 °C   Standard Deviation = 0.0099 °C

Site and Record Information for
IES89H7_207

Serial Number: 52
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 36°24.53 N 67°47.06 W DEPTH: 4880 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 6, 1988	0959	Oc200
RELEASE:	Jun 17, 1989	1545	Oc207

TRAVEL TIME RECORDS
Fig. 6.23 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 6, 1988	110155	-5004.968
LAST DATA POINT:	Jun 17, 1989	152812	4023.470

Number of Points: 18058
Sampling Interval: 0.5 hr

Minimum τ = 0.11328 s   Mean = 0.12160 s
Maximum τ = 0.13790 s   Standard Deviation = .00329 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.5

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 3143 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 7, 1988	1200	-4980
LAST DATA POINT:	Jun 16, 1989	1800	4002

Number of Points: 1498
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 533.8 m   Mean = 832.6 m
Maximum Z_{12} = 975.8 m   Standard Deviation = 62.0 m

Table 26: **IES89H7_207**

Site and Record Information for IES89H7_210

Serial Number: 41
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 36°24.90 N 67°48.10 W DEPTH: 4880 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 17, 1989	1756	Oc207
RELEASE:	Aug 16, 1989	1236	Oc210

TRAVEL TIME RECORDS

Fig. 6.24 and 10.5

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 17, 1989	190152	4027.031
LAST DATA POINT:	Aug 16, 1989	123152	5460.531

Number of Points: 2868
Sampling Interval: 0.5 hr

Minimum τ = 0.12458 s Mean = 0.13918 s
Maximum τ = 0.15612 s Standard Deviation = 0.01038 s

40HRLP THERMOCLINE DEPTH RECORDS

Fig. 13.5

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 3127 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 18, 1989	1800	4050
LAST DATA POINT:	Aug 15, 1989	1200	5436

Number of Points: 232
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 175.2 m Mean = 483.2 m
Maximum Z_{12} = 749.8 m Standard Deviation = 193.9 m

Table 27: **IES89H7_210**

Site and Record Information for PIES89I1

Serial Number: 72
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 33822

POSITION: 38°47.54 N DEPTH: 3828 m
68°06.38 W

	DATE	GMT	CRUISE
LAUNCH:	May 24, 1988	2328	Oc200
RELEASE:	May 30, 1989	1805	Oc207

TRAVEL TIME RECORDS
Fig. 6.25 and 10.6

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 25, 1988	003155	-5303.468
LAST DATA POINT:	Feb 1, 1989	233507	767.75853

Number of Points: 12143
Sampling Interval: 0.5 hr

Minimum τ = 0.29219 s Mean = 0.30313 s
Maximum τ = 0.31320 s Standard Deviation = 0.00371 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.6

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 5921 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 26, 1988	0000	-5280
LAST DATA POINT:	Feb 1, 1989	0000	744

Number of Points: 1005
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 18.0 m Mean = 161.1 m
Maximum Z_{12} = 358.6 m Standard Deviation = 69.4 m

Table 28: **PIES89I1**

PIES89I1 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.7

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 25, 1988	004449	-5303.253
LAST DATA POINT:	Feb 1, 1989	234801	767.800

Number of Points: 12143
Sampling Interval: 0.5 hrs

Minimum = 3893.05 dbar
Maximum = 3894.68 dbar
Mean = 3893.88 dbar
Standard Deviation = 0.31903 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.7 and 11.3

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= 0.0

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42487	..09608	.09337	.02232	.08065	.06279	.02653	.01372
G^o:	353.30	335.36	21.11	23.11	175.15	180.68	176.13	177.48

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 25, 1988	124449	-5291.253
LAST DATA POINT:	Feb 1, 1989	234812	767.800

Number of Points: 12119
Sampling Interval: 0.5 hrs

Minimum = -0.1907 dbar
Maximum = 0.1089 dbar
Mean = -0.0001 dbar
Standard Deviation = 0.0433 dbar

PIES89I1 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 26, 1988	1200	-5268
LAST DATA POINT:	Feb 1, 1989	0000	744

Number of Points: 1003
Sampling Interval: 6.0 hrs

Minimum = -0.1535 dbar Mean = -0.0002 dbar
Maximum = 0.0803 dbar Standard Deviation = 0.0404 dbar

TEMPERATURE RECORDS

Fig. 8.7 and 12.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 25, 1988	005921	-5303.011
LAST DATA POINT:	Feb 1, 1989	000232	768.042

Number of Points: 12143
Sampling Interval: 0.5 hrs

Minimum = 2.493°C Mean = 2.527°C
Maximum = 2.799°C Standard Deviation = 0.0197°C

40HRLP TEMPERATURE RECORDS

Fig. 15.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 26, 1988	0000	-5280
LAST DATA POINT:	Feb 1, 1989	0000	744

Number of Points: 1005
Sampling Interval: 6.0 hrs

Minimum = 2.494 °C Mean = 2.527 °C
Maximum = 2.607 °C Standard Deviation = 0.016 °C

Site and Record Information for PIES89I2

Serial Number: 66
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 31162

POSITION: 38°20.90 N 67°59.60 W DEPTH: 4720 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 9, 1988	1813	Oc200
RELEASE:	May 30, 1989	0649	Oc207

TRAVEL TIME RECORDS
Fig. 6.26 and 10.6

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	193155	-4924.468
LAST DATA POINT:	May 30, 1989	062938	3582.464

Number of Points: 17015
Sampling Interval: 0.5 hr

Minimum τ = 0.04123 s Mean = 0.05942 s
Maximum τ = 0.06530 s Standard Deviation = 0.00264 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.6

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 1313 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	1800	-4902
LAST DATA POINT:	May 29, 1989	0600	3558

Number of Points: 1411
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 92.9 m Mean = 184.3 m
Maximum Z_{12} = 515.9 m Standard Deviation = 49.4 m

Table 29: **PIES89I2**

PIES89I2 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.8

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	194449	-4924.253
LAST DATA POINT:	May 30, 1989	064232	3582.709

Number of Points: 17015
Sampling Interval: 0.5 hrs

Minimum = 4328.91 dbar Mean = 4329.90 dbar
Maximum = 4330.79 dbar Standard Deviation = 0.33345 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.8 and 11.3

$P_{residual} = P_{measured} - MEAN - -TIDE$

DRIFT= $P_1 exp(-P_2 t) + P_3 + P_4 t$

where t = Time of sample in hours, starting with t = 13.0hrs for the first data point

$P_1 =$ -0.369500 dbar

$P_2 =$ 0.002260 hr^{-1}

$P_3 =$ -0.073663 dbar

$P_4 =$ 0.000022 dbar hr^{-1}

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42247	..09551	.09385	.02244	.07996	.06307	.02624	.01422
G°:	352.84	334.30	19.86	21.59	175.85	180.80	176.84	176.87

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	074449	-4912.253
LAST DATA POINT:	May 30, 1989	064232	3582.709

Number of Points: 16991
Sampling Interval: 0.5 hrs

Minimum = -0.1388 dbar Mean = 0.0000 dbar
Maximum = 0.1965 dbar Standard Deviation = 0.0444 dbar

PIES89I2 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	0600	-4890
LAST DATA POINT:	May 29, 1989	0600	3558

Number of Points: 1409
Sampling Interval: 6.0 hrs

Minimum = -0.1047 dbar   Mean = 0.0001 dbar
Maximum = 0.1640 dbar   Standard Deviation = 0.0407 dbar

TEMPERATURE RECORDS

Fig. 8.8 and 12.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	195921	-4924.011
LAST DATA POINT:	May 30, 1989	065704	3582.951

Number of Points: 17015
Sampling Interval: 0.5 hrs

Minimum = 2.454°C   Mean = 2.489°C
Maximum = 2.550°C   Standard Deviation = 0.0116°C

40HRLP TEMPERATURE RECORDS

Fig. 15.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	1800	-4902
LAST DATA POINT:	May 29, 1989	0600	3558

Number of Points: 1411
Sampling Interval: 6.0 hrs

Minimum = 2.460 °C   Mean = 2.489 °C
Maximum = 2.544 °C   Standard Deviation = 0.011 °C

Site and Record Information for PIES89I4

Serial Number: 54
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 17849

POSITION: 37°18.50 N 67°39.30 W DEPTH: 4775 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 8, 1988	1748	Oc200
RELEASE:	Jun 16, 1989	0804	Oc207

TRAVEL TIME RECORDS
Fig. 6.27 and 10.6

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 8, 1988	190155	-4948.968
LAST DATA POINT:	Jun 16, 1989	075928	3991.991

Number of Points: 17883
Sampling Interval: 0.5 hr

Minimum τ = 0.35584 s Mean = 0.36708 s
Maximum τ = 0.39509 s Standard Deviation = 0.010821 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.6

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 7610 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	1800	-4926
LAST DATA POINT:	Jun 15, 1989	0600	3966

Number of Points: 1483
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 117.3 m Mean = 636.7 m
Maximum Z_{12} = 832.7 m Standard Deviation = 204.7 m

Table 30: **PIES89I4**

PIES89I4 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.9

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 8, 1988	190000	-4949.000
LAST DATA POINT:	Jun 16, 1989	075733	3991.959

Number of Points: 17883
Sampling Interval: 0.5 hrs

Minimum = 4906.90 dbar   Mean = 4907.67 dbar
Maximum = 4908.56 dbar   Standard Deviation = 0.32976 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.9 and 11.3

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= 0.0

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.42224	.09503	.09424	.02247	.07800	.06181	.02567	.01369
G°:	353.21	333.82	20.82	22.58	177.12	182.27	177.86	180.76

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	070000	-4937.000
LAST DATA POINT:	Jun 16, 1989	075732	3991.959

Number of Points: 17859
Sampling Interval: 0.5 hrs

Minimum = -0.3536 dbar   Mean = 0.0002 dbar
Maximum = 0.3154 dbar   Standard Deviation = 0.0966 dbar

PIES89I4 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	0600	−4914
LAST DATA POINT:	Jun 15, 1989	0600	3966

Number of Points: 1481
Sampling Interval: 6.0 hrs

Minimum = -0.3229 dbar Mean = 0.0007 dbar
Maximum = 0.2731 dbar Standard Deviation = 0.0953 dbar

TEMPERATURE RECORDS

Fig. 8.9 and 12.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 8, 1988	190000	−4949.000
LAST DATA POINT:	Jun 16, 1989	075733	3991.959

Number of Points: 17883
Sampling Interval: 0.5 hrs

Minimum = 2.267°C Mean = 2.323°C
Maximum = 2.380°C Standard Deviation = 0.0132°C

40HRLP TEMPERATURE RECORDS

Fig. 15.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	1800	−4926
LAST DATA POINT:	Jun 15, 1989	0600	3966

Number of Points: 1483
Sampling Interval: 6.0 hrs

Minimum = 2.267 °C Mean = 2.323 °C
Maximum = 2.353 °C Standard Deviation = 0.013 °C

Site and Record Information for PIES89I5

Serial Number: 73
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 31694

POSITION: 36°49.73 N DEPTH: 4975 m
67°27.57 W

	DATE	GMT	CRUISE
LAUNCH:	May 23, 1988	2055	Oc200
RELEASE:	Jun 3, 1989	0837	Oc210

TRAVEL TIME RECORDS

Fig. 6.28 and 10.6

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 23, 1988	223231	-5329.458
LAST DATA POINT:	Jun 3, 1989	080231	3680.042

Number of Points: 18020
Sampling Interval: 0.5 hr

Minimum τ = 0.16916 s Mean = 0.18094 s
Maximum τ = 0.21013 s Standard Deviation = 0.00703 s

40HRLP THERMOCLINE DEPTH RECORDS

Fig. 13.6

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 4246 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 25, 1988	0000	-5304
LAST DATA POINT:	Jun 2, 1989	0600	3654

Number of Points: 1494
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 279.5 m Mean = 809.4 m
Maximum Z_{12} = 1008.3 m Standard Deviation = 130.5 m

Table 31: **PIES89I5**

PIES89I5 (continued)

MEASURED PRESSURE RECORDS

Fig. 7.10

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 23, 1988	224523	-5329.244
LAST DATA POINT:	Jun 3, 1989	081523	3680.257

Number of Points: 18020
Sampling Interval: 0.5 hrs

Minimum = 5081.76 dbar Mean = 5082.61 dbar
Maximum = 5083.47 dbar Standard Deviation = 0.32507 dbar

RESIDUAL PRESSURE RECORDS

Fig. 9.10 and 11.3

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$

DRIFT= 0.0

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.41636	..09365	.09320	.02226	.07641	.06031	.02513	.01337
G°:	353.51	334.34	21.62	23.57	177.68	182.75	178.58	179.85

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 24, 1988	104523	-5317.244
LAST DATA POINT:	Jun 3, 1989	081523	3679.257

Number of Points: 17996
Sampling Interval: 0.5 hrs

Minimum = -0.3650 dbar Mean = 0.0000 dbar
Maximum = 0.2510 dbar Standard Deviation = 0.0943 dbar

PIES89I5 (continued)

40HRLP PRESSURE RECORDS

Fig. 14.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 25, 1988	1200	-5292
LAST DATA POINT:	Jun 2, 1989	0600	3654

Number of Points: 1492
Sampling Interval: 6.0 hrs

Minimum = -0.3298 dbar   Mean = 0.0009 dbar
Maximum = 0.2186 dbar   Standard Deviation = 0.0921 dbar

TEMPERATURE RECORDS

Fig. 8.10 and 12.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 23, 1988	225955	-5329.001
LAST DATA POINT:	Jun 3, 1989	082955	3680.499

Number of Points: 18020
Sampling Interval: 0.5 hrs

Minimum = 2.430°C   Mean = 2.491°C
Maximum = 2.535°C   Standard Deviation = 0.0137°C

40HRLP TEMPERATURE RECORDS

Fig. 15.3

	DATE	GMT	YEARHOUR
1st DATA POINT:	May 25, 1988	0000	-5304
LAST DATA POINT:	Jun 2, 1989	0600	3654

Number of Points: 1494
Sampling Interval: 6.0 hrs

Minimum = 2.429 °C   Mean = 2.491 °C
Maximum = 2.531 °C   Standard Deviation = 0.0132°C

Site and Record Information for
IES89J1

Serial Number: 44
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 39°10.04 N DEPTH: 3480 m
67°47.08 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 10, 1988	1904	Oc200
RELEASE:	May 30, 1989	2350	Oc207

TRAVEL TIME RECORDS
Fig. 6.29 and 10.7

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	200155	-4899.968
LAST DATA POINT:	May 30, 1989	232906	3599.485

Number of Points: 17000
Sampling Interval: 0.5 hr

Minimum τ = 0.236471s Mean = 0.25014 s
Maximum τ = 0.25823 s Standard Deviation = 0.004895 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.7

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 4946 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	1800	-4878
LAST DATA POINT:	May 30, 1989	0000	3576

Number of Points: 1410
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 59.6 m Mean = 193.4 m
Maximum Z_{12} = 487.1 m Standard Deviation = 92.7 m

Table 32: **IES89J1**

Site and Record Information for
IES89J2

Serial Number: 37
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 38°45.59 N 67°21.57 W DEPTH: 4270 m

	DATE	GMT	CRUISE
LAUNCH:	Jun 10, 1988	1450	Oc200
RELEASE:	May 31, 1989	0459	Oc207

TRAVEL TIME RECORDS
Fig. 6.30 and 10.7

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	154156	-4904.301
LAST DATA POINT:	May 31, 1989	043535	3604.593

Number of Points: 17019
Sampling Interval: 0.5 hr

Minimum τ = 0.07790 s   Mean = 0.09293 s
Maximum τ = 0.09850 s   Standard Deviation = 0.00272 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.7

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 1955 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	1200	-4884
LAST DATA POINT:	May 30, 1989	0600	3582

Number of Points: 1412
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 99.1 m   Mean = 189.3 m
Maximum Z_{12} = 464.8 m   Standard Deviation = 51.2 m

Table 33: **IES89J2**

Site and Record Information for IES89J3

Serial Number: 50
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 38°09.03 N DEPTH: 4635 m
67°10.06 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 9, 1988	0849	Oc200
RELEASE:	Jun 6, 1989	2246	Oc207

TRAVEL TIME RECORDS
Fig. 6.31 and 10.7

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 9, 1988	100058	-4933.984
LAST DATA POINT:	Jun 6, 1989	223058	3766.516

Number of Points: 17402
Sampling Interval: 0.5 hr

Minimum τ = 0.18466 s Mean = 0.17479 s
Maximum τ = 0.15779 s Standard Deviation = 0.00716 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.7

Z_{12} Conversion equation: $Z_{12} = -19000 ms^{-1} \cdot \tau_d + B$
where B= 3641 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	1200	-4908
LAST DATA POINT:	Jun 6, 1989	0000	3744

Number of Points: 1443
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 150.1 m Mean = 319.9 m
Maximum Z_{12} = 624.7 m Standard Deviation = 135.3 m

Table 34: **IES89J3**

Site and Record Information for IES89J4

Serial Number: 35
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 37°37.84 N DEPTH: 4875 m
67°00.65 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 10, 1988	0649	Oc200
RELEASE:	Jun 7, 1989	0701	Oc207

TRAVEL TIME RECORDS
Fig. 6.32 and 10.7

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 10, 1988	080708	–4911.881
LAST DATA POINT:	Jun 7, 1989	060708	3774.119

Number of Points: 17373
Sampling Interval: 0.5 hr

Minimum τ = 0.07105 s   Mean = 0.08170 s
Maximum τ = 0.10452 s   Standard Deviation = 0.08111 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.7

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 2163 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 11, 1988	0600	–4890
LAST DATA POINT:	Jun 6, 1989	0600	3750

Number of Points: 1441
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 198.9 m   Mean = 611.7 m
Maximum Z_{12} = 798.9 m   Standard Deviation = 153.0 m

Table 35: **IES89J4**

Site and Record Information for
IES89J5

Serial Number: 62
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 024
Additional Sensors: None

POSITION: 36°59.83 N DEPTH: 4955 m
66°56.52 W

	DATE	GMT	CRUISE
LAUNCH:	Jun 6, 1988	1913	Oc200
RELEASE:	Jun 16, 1989	0047	Oc207

TRAVEL TIME RECORDS
Fig. 6.33 and 10.7

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 6, 1988	203155	-4995.468
LAST DATA POINT:	Jun 16, 1989	002928	3984.491

Number of Points: 17961
Sampling Interval: 0.5 hr

Minimum τ = 0.19721 s Mean = 0.20778 s
Maximum τ = 0.23468 s Standard Deviation = 0.00525 s

40HRLP THERMOCLINE DEPTH RECORDS
Fig. 13.7

Z_{12} Conversion equation: $Z_{12} = -19000ms^{-1} \cdot \tau_d + B$
where B= 4756 m
τ_d= Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jun 07, 1988	1800	-4974
LAST DATA POINT:	Jun 15, 1989	0000	3860

Number of Points: 1490
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 312.4 m Mean = 808.4 m
Maximum Z_{12} = 990.8 m Standard Deviation = 99.6 m

Table 36: **IES89J5**

3 Half-Hourly Individual Plots

Plots are presented for the individual time series of half-hourly travel time, bottom pressure, temperature, and residual bottom pressure (detided and dedrifted).

The plots for each sensor are displayed in a standardized window. All sensors have a common time axis which starts at −5376 (22-May-1988 referenced to 1-Jan-1989) and extends to 6036. This time period is displayed in four panels or subplots, two per page. Each panel covers 2928 hr (one third of a leap year). A small tic is placed at each day (0000 GMT) and larger tics denote weeks (168 hr). All IES records were encompassed by this period except IES89G1 which required a third page. For comparison, labels indicating specific dates are centered about their yearhour equivalent (for example a label associates "1-Jan-89" with 0.0 yearhour).

Vertical axes for each sensor will be either common or have common increment. Travel time is plotted within a 4 msec window in increments of .005 sec. Pressure is plotted in a 2 dbar window centered about zero. The mean was removed from the series for the purpose of plotting and it's value is indicated in the y-axis label. Temperature is plotted in a .15° C window adjusted vertically to enclose all the record's variation. After detiding and dedrifting the bottom pressure, (residual) may be plotted within a 0.8 dbar window centered about zero.

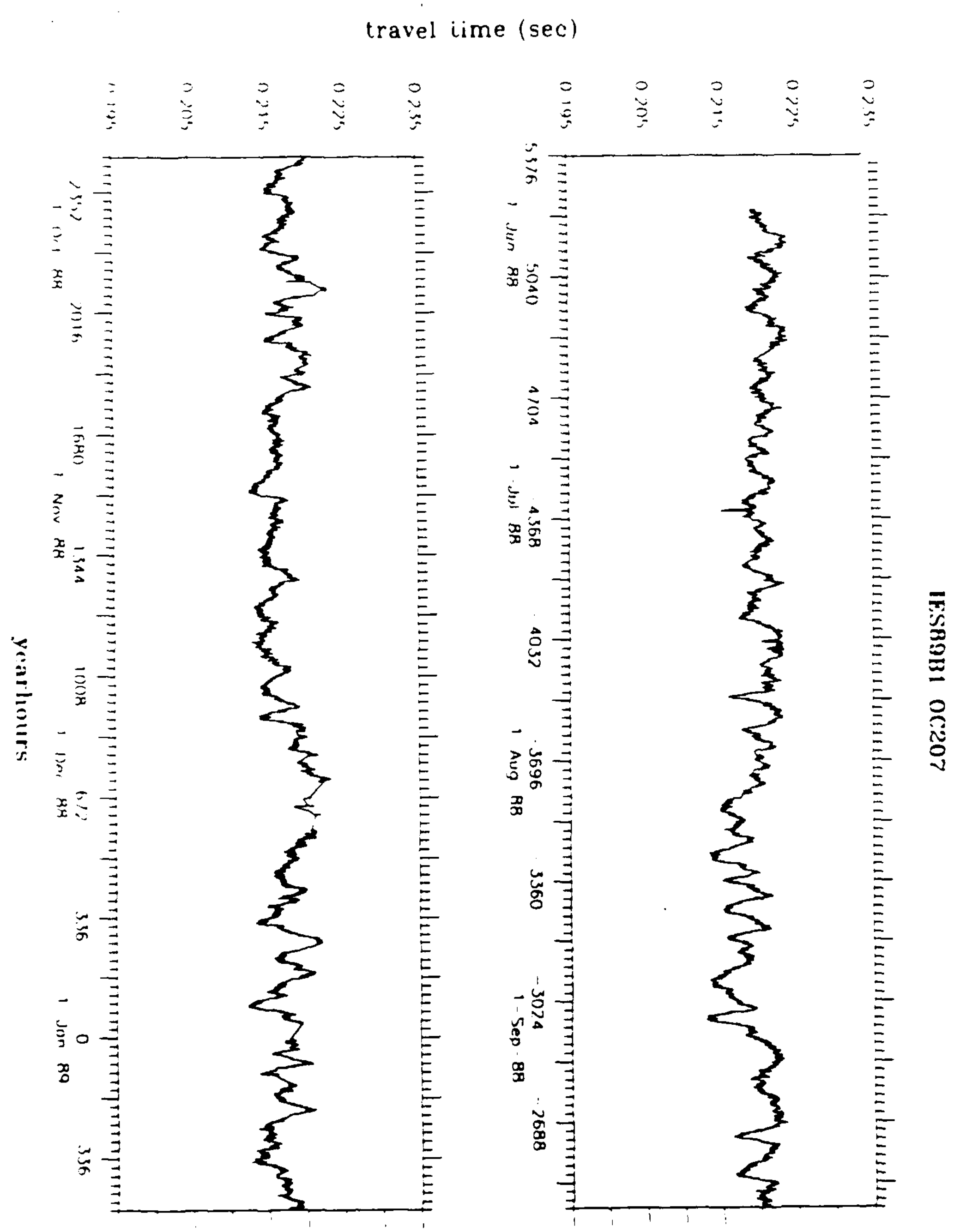
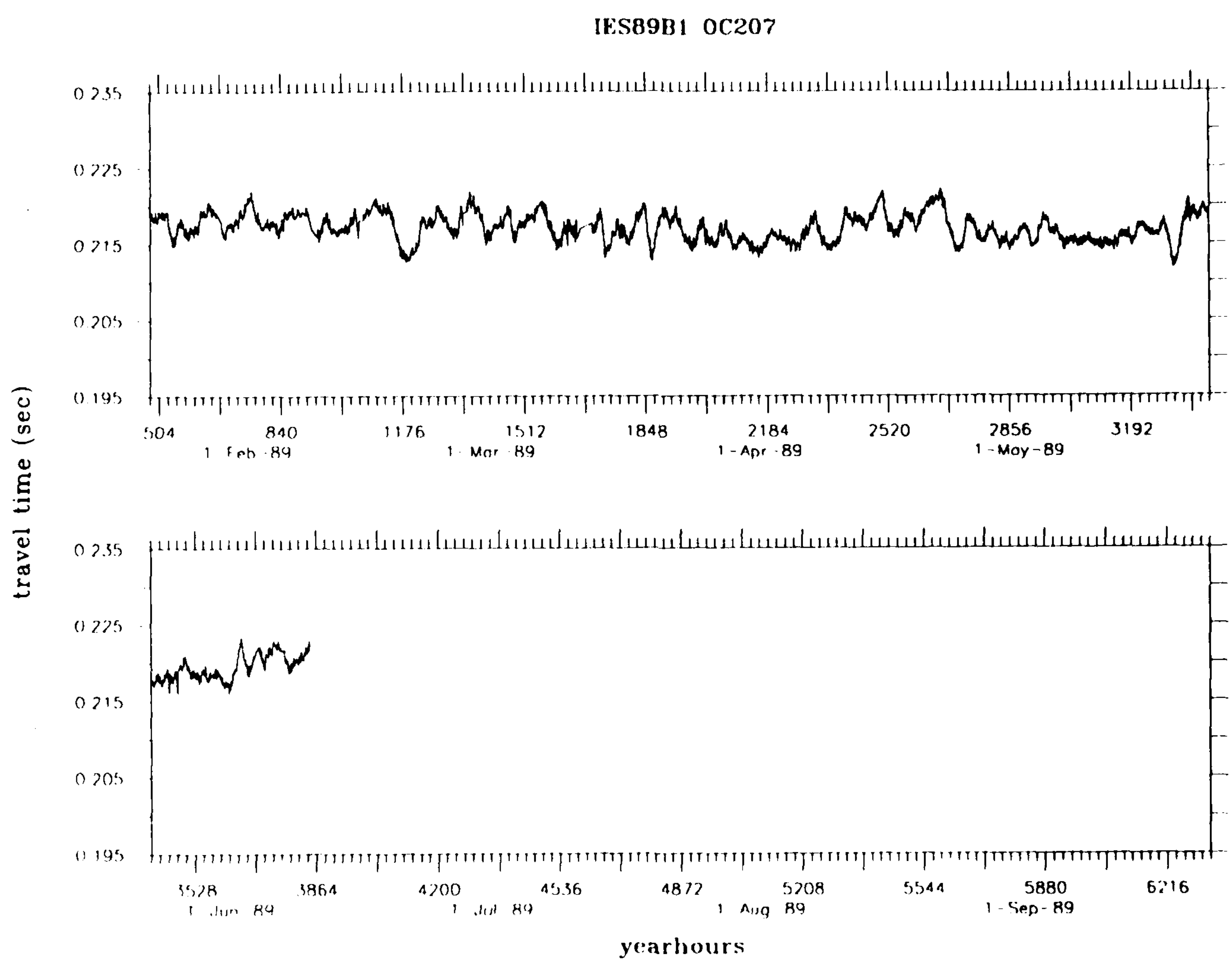


Figure 6.1: Half-Hourly Travel Times. IES89B1_207


IES89B1 OC207
travel time (sec)
0.235
0.225
0.215
0.205
0.195
504
840
1176
1512
1848
2184
2520
2856
3192
1 Feb 89
1 Mar 89
1 Apr 89
1 May 89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1 Jun 89
1 Jul 89
1 Aug 89
1 Sep 89
yearhours

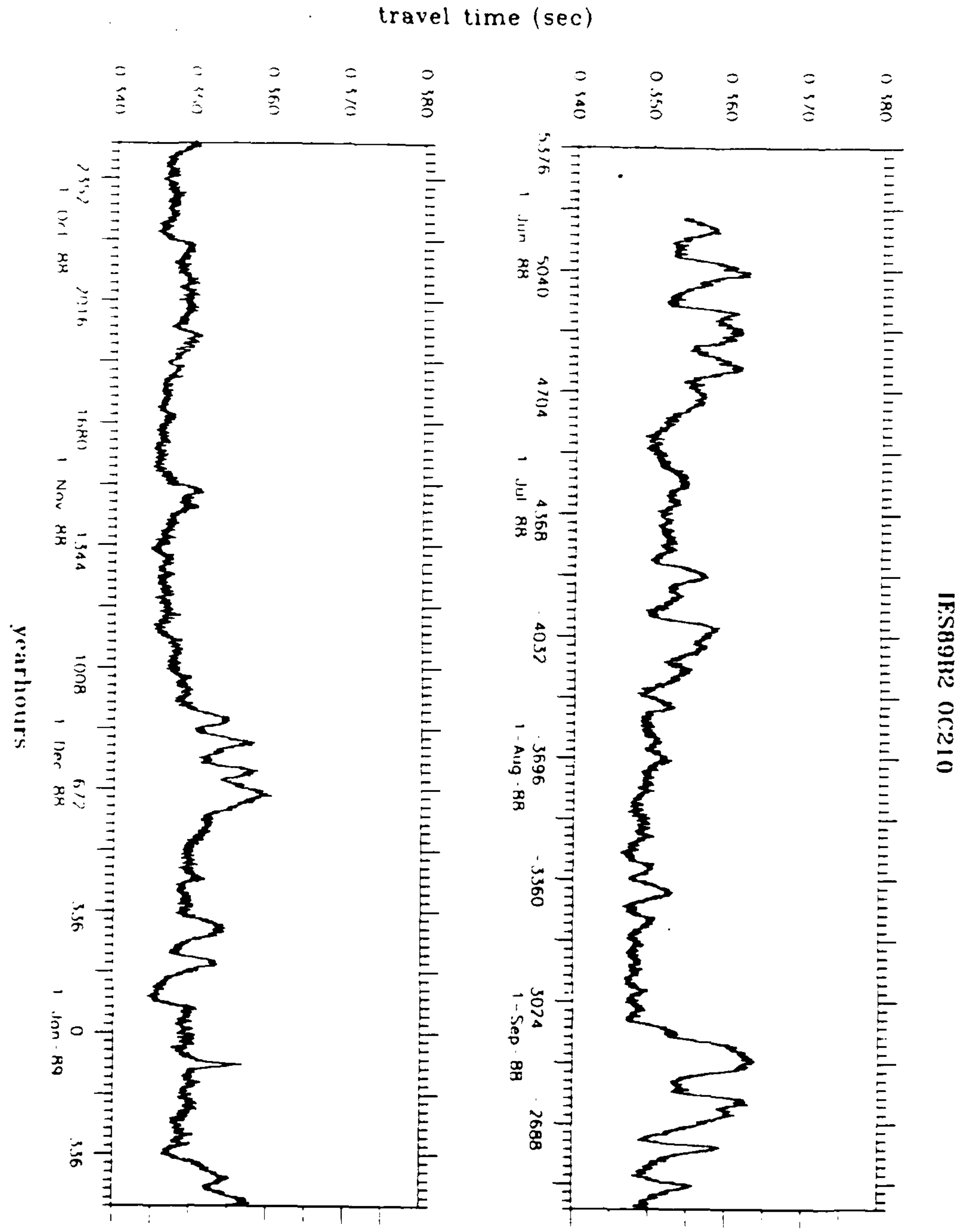
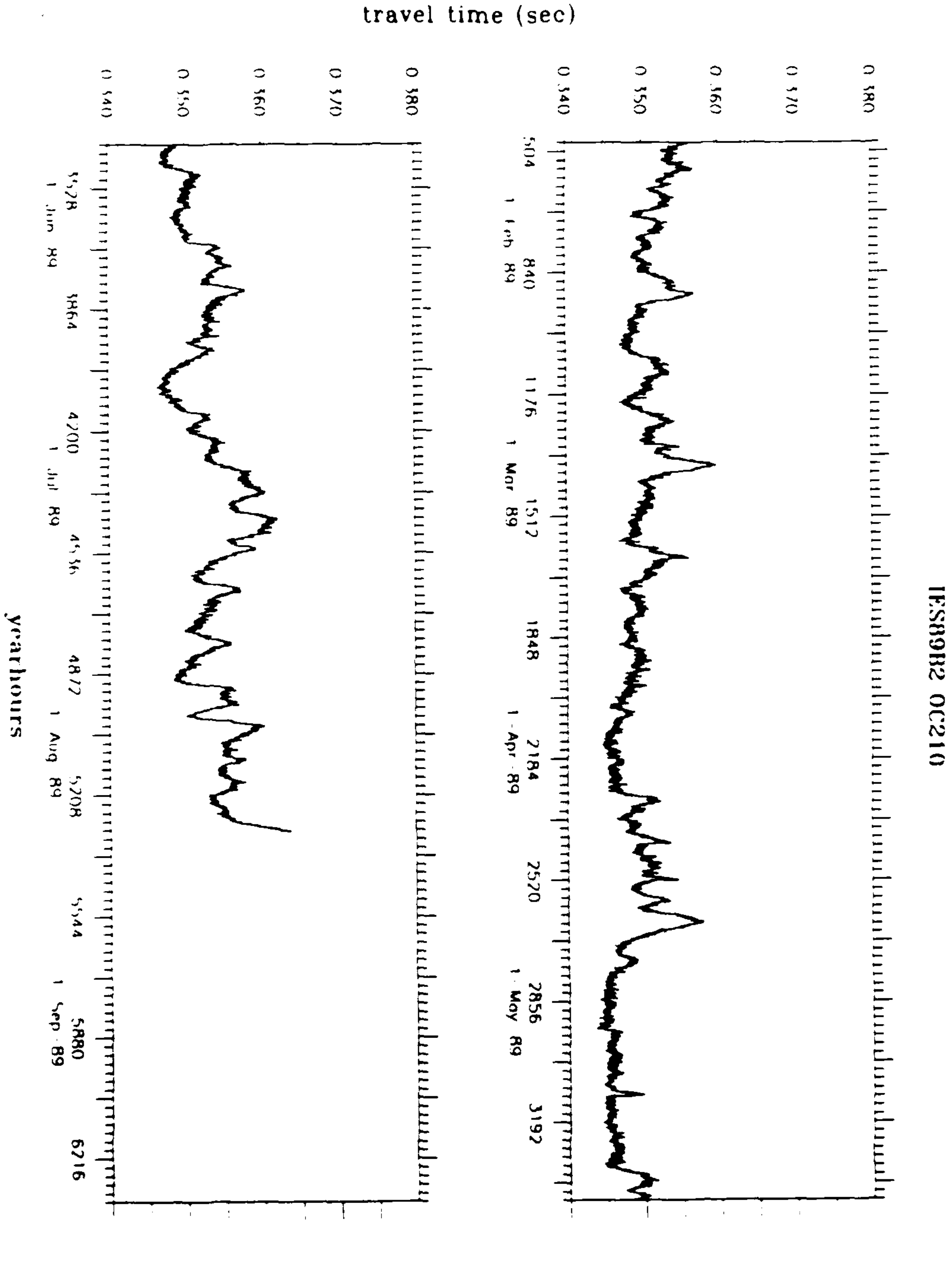


Figure 6.2: Half-Hourly Travel Times. IES89B2_210


IES89B2 OC210
travel time (sec)
0.340
0.350
0.360
0.370
0.380
504
840
1 Feb 89
1176
1512
1 Mar 89
1848
2184
1 Apr 89
2520
2856
1 May 89
3192
3528
1 Jun 89
3864
4200
1 Jul 89
4536
4872
1 Aug 89
5208
5544
5880
1 Sep 89
6216
yearhours

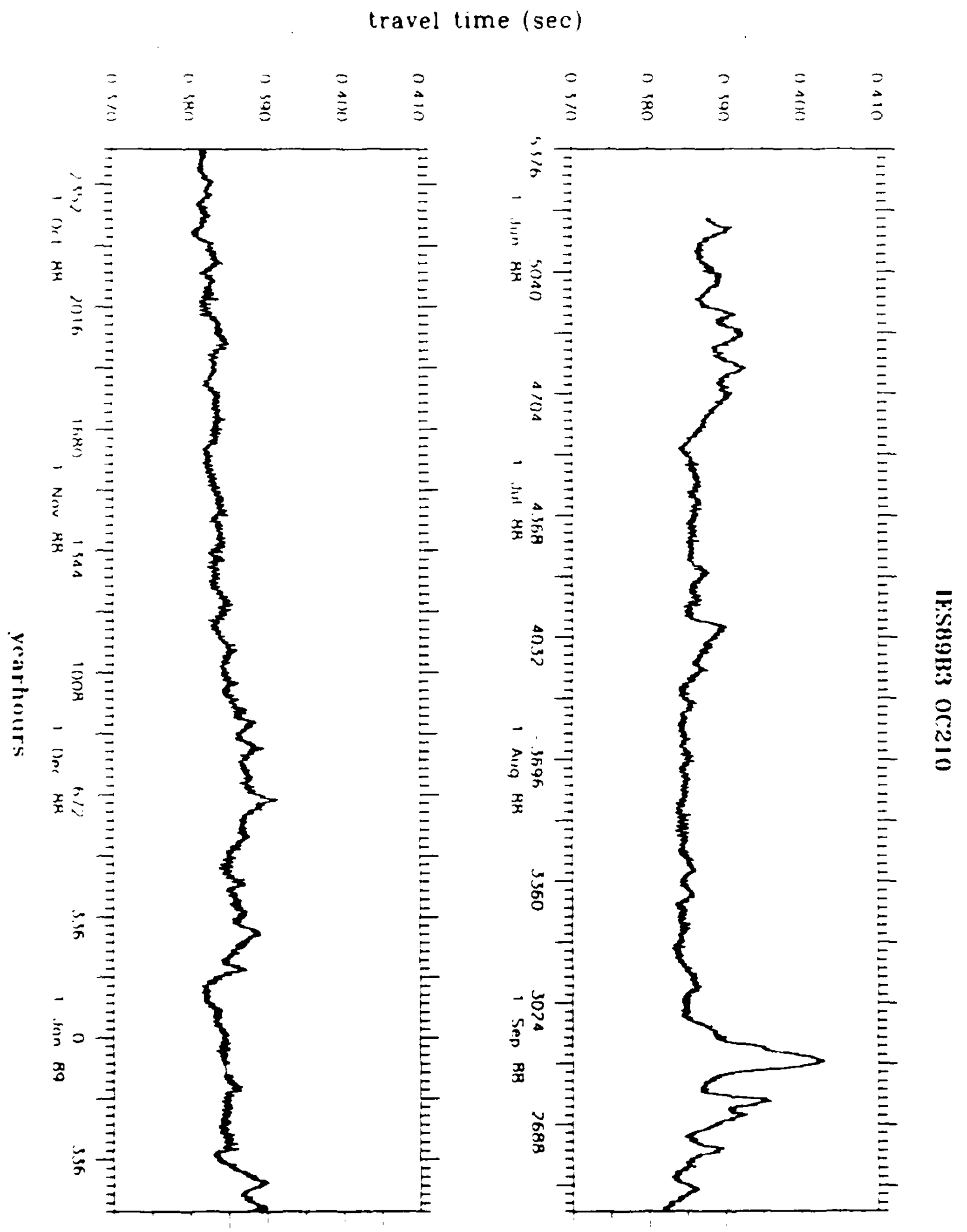
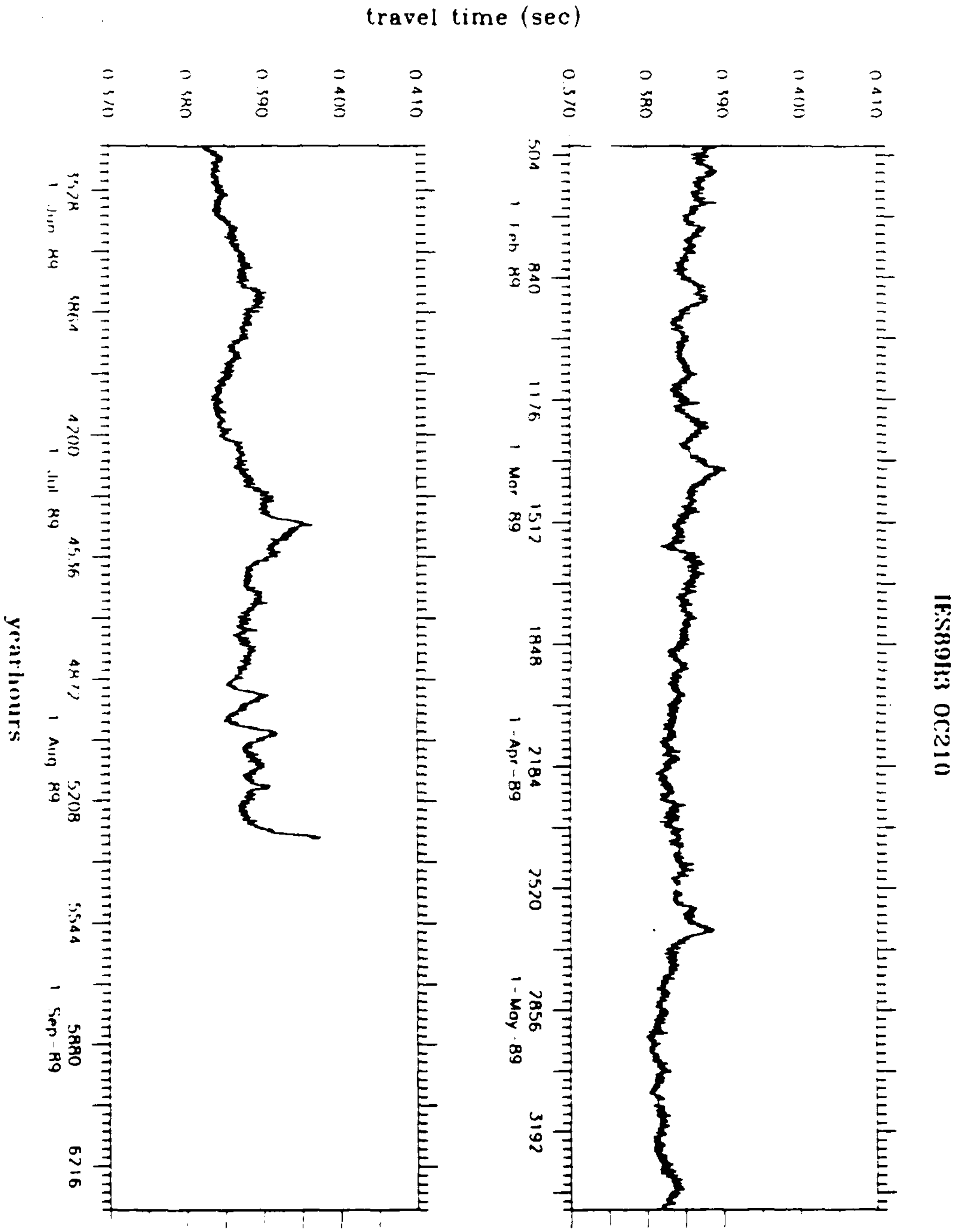


Figure 6.3: Half-hourly Travel Times. IES89B3_210


IES89B3 OC210
travel time (sec)
0.410
0.400
0.390
0.380
0.370
504
840
1176
1512
1848
2184
2520
2856
3192
1 Feb 89
1 Mar 89
1-Apr-89
1-May-89
5880
6216
1 Sep-89
1 Aug 89
1 Jul 89
yearhours

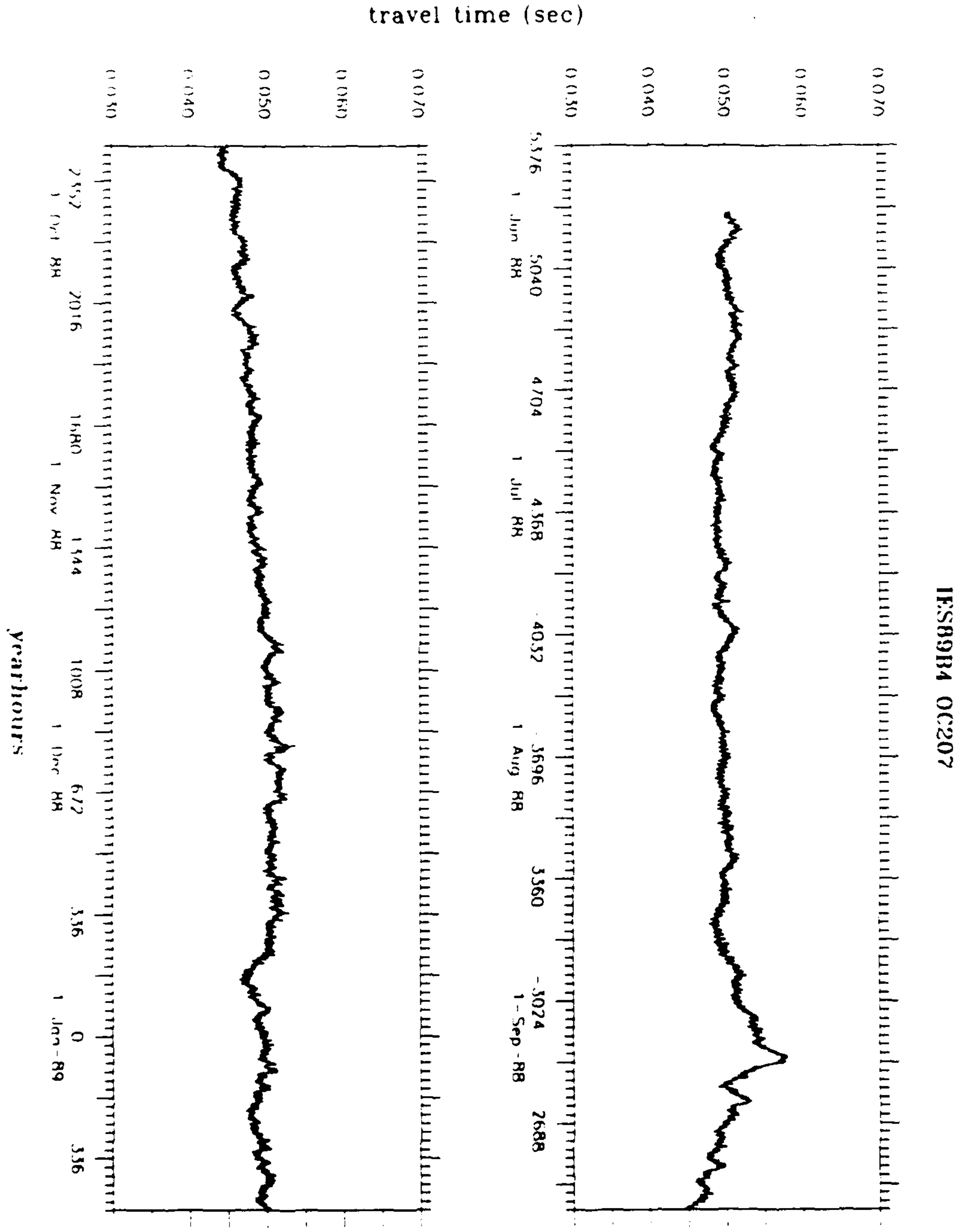
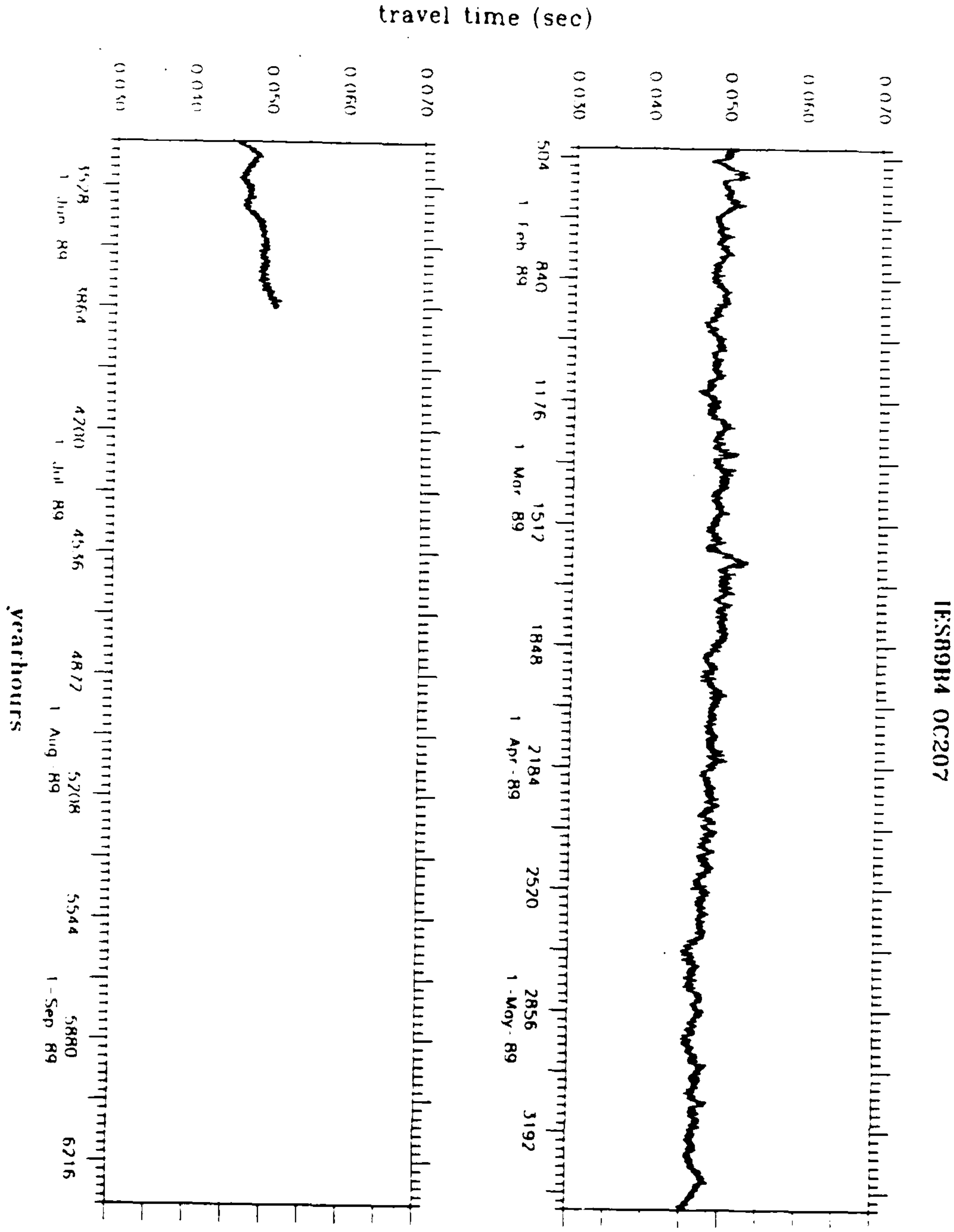


Figure 6.4: Half-Hourly Travel Times. IES89B4_207


IES89B4 OC207
travel time (sec)
yearhours
1 Feb 89
1 Mar 89
1 Apr 89
1 May 89
1 Jun 89
1 Jul 89
1 Aug 89
1 Sep 89

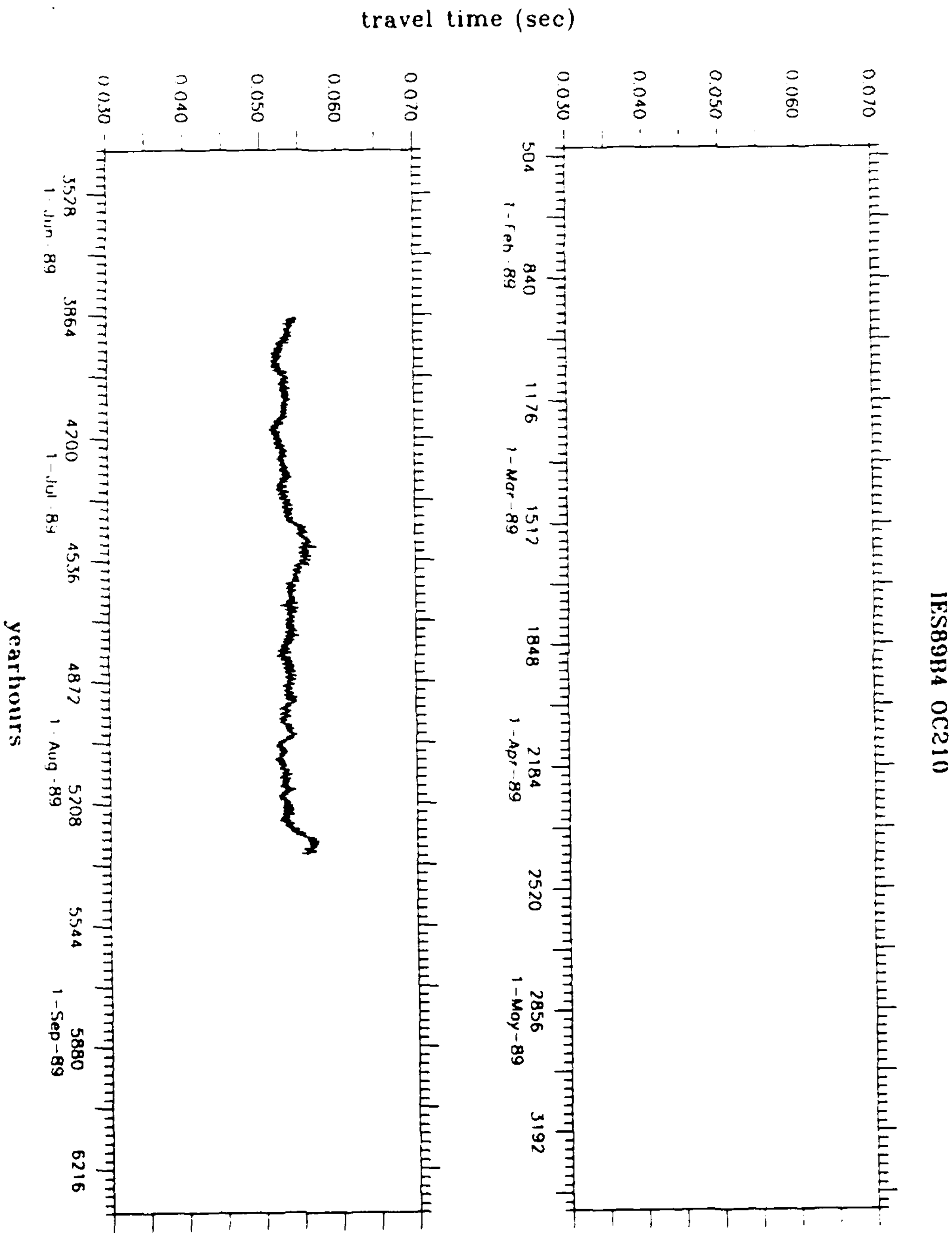


Figure 6.5: Half-Hourly Travel Times. IES89B4_210

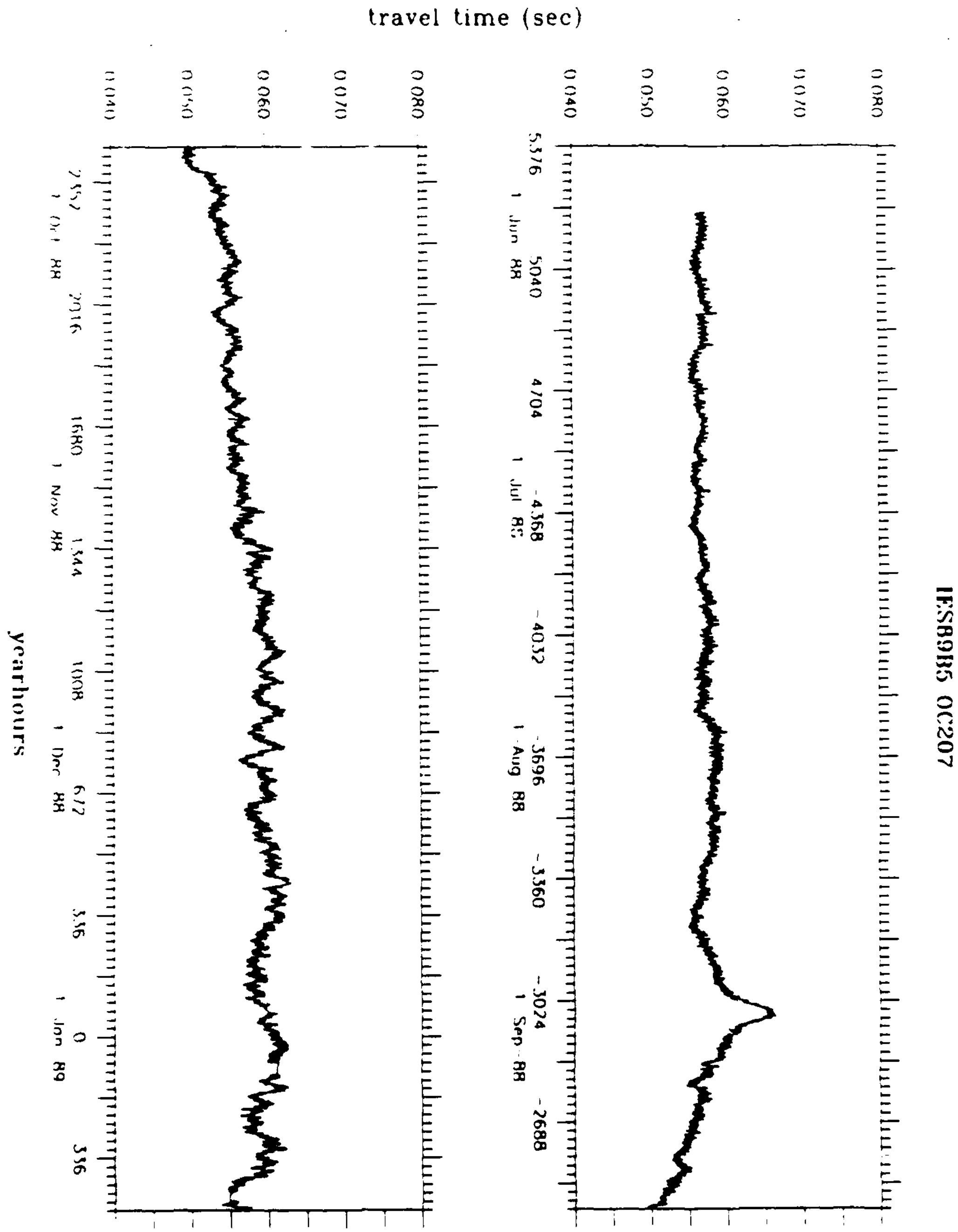
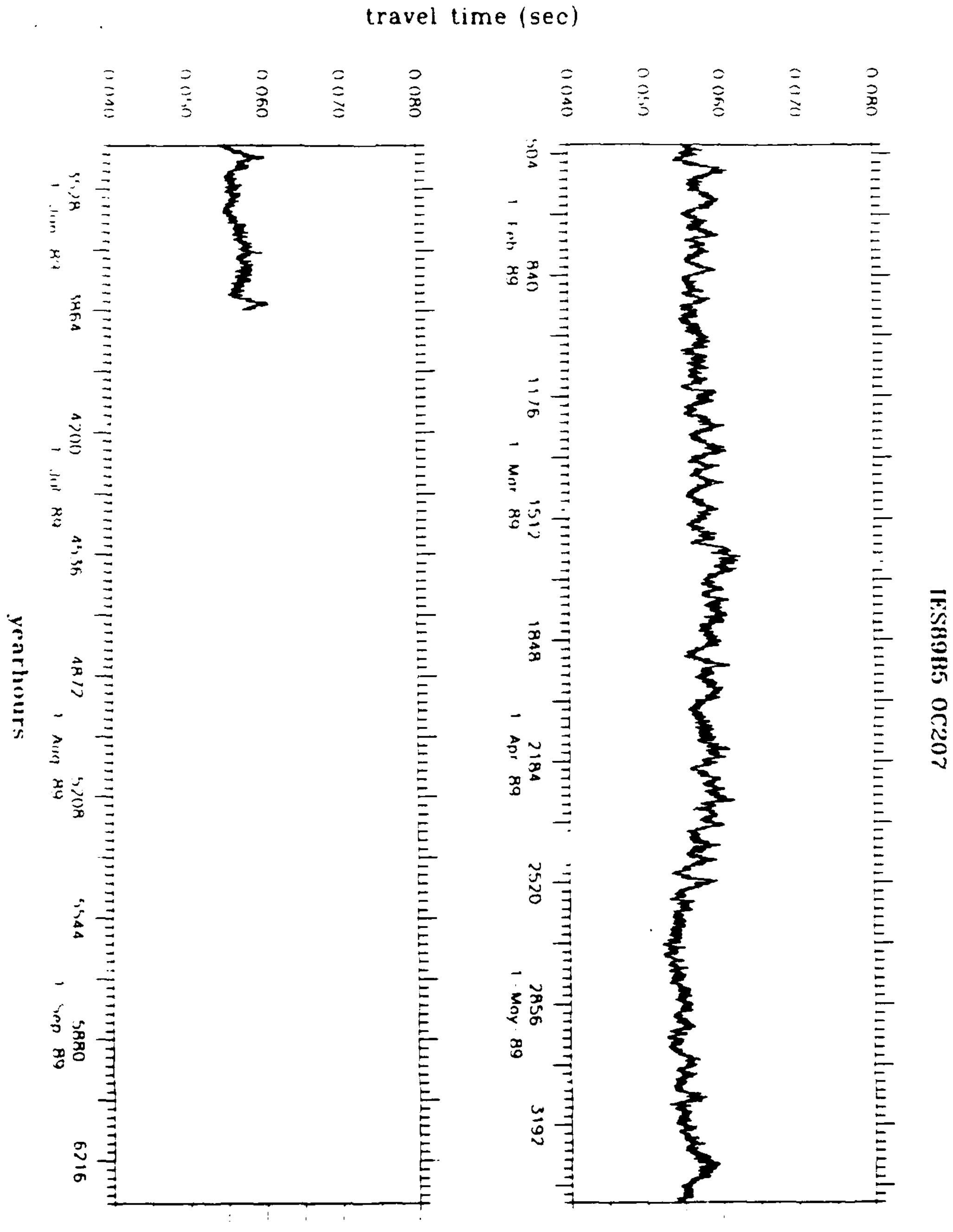


Figure 6.6: Half-Hourly Travel Times. IES89B5_207


IES89B5 OC207
travel time (sec)
0.080
0.070
0.060
0.050
0.040
504
840
1 Feb 89
1176
1512
1 Mar 89
1848
2184
1 Apr 89
2520
2856
1 May 89
3192
0.080
0.060
3864
4200
4872
5880
1 Sep 89
6216
yearhours

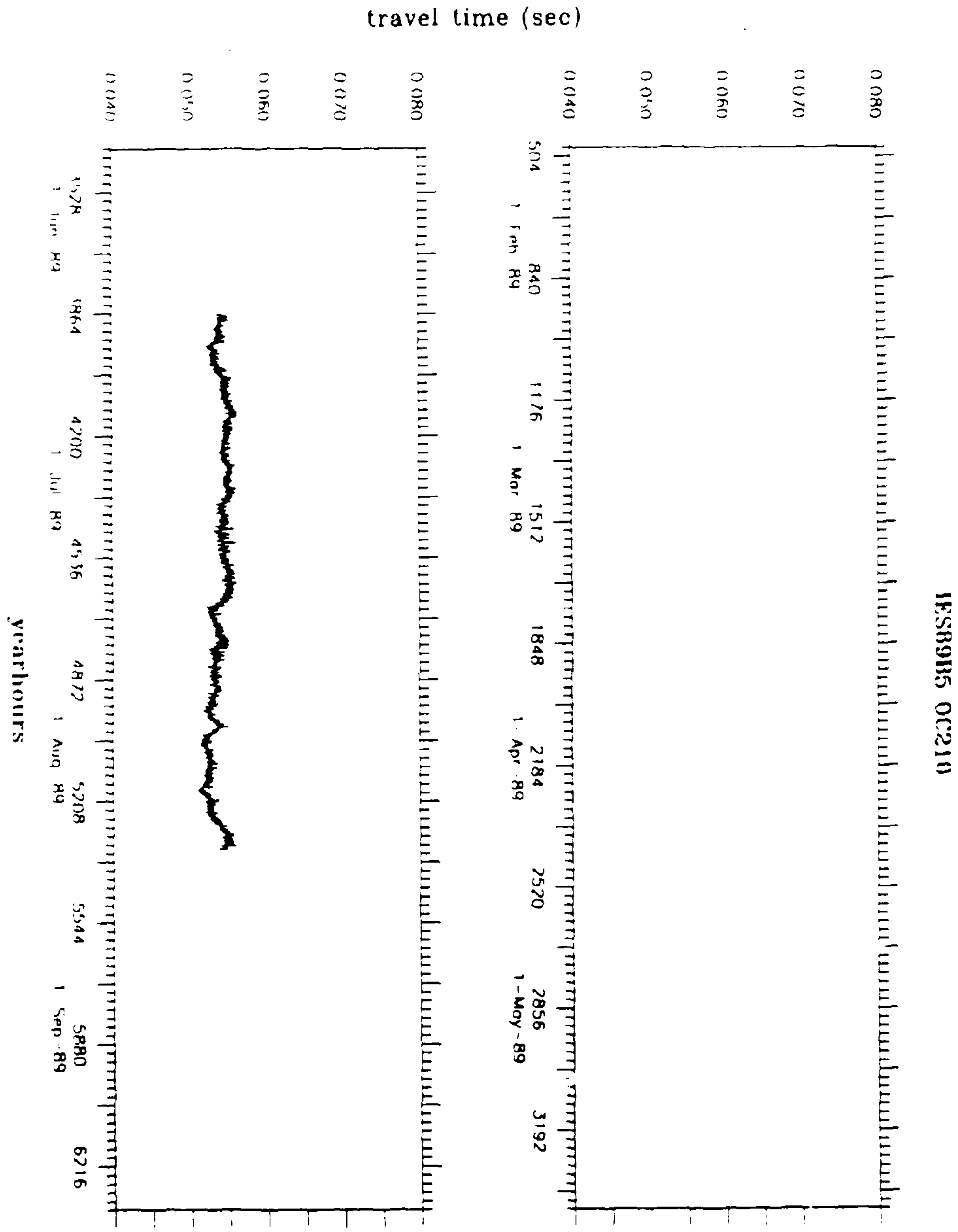


Figure 6.7: Half-Hourly Travel Times. IES89B5_210

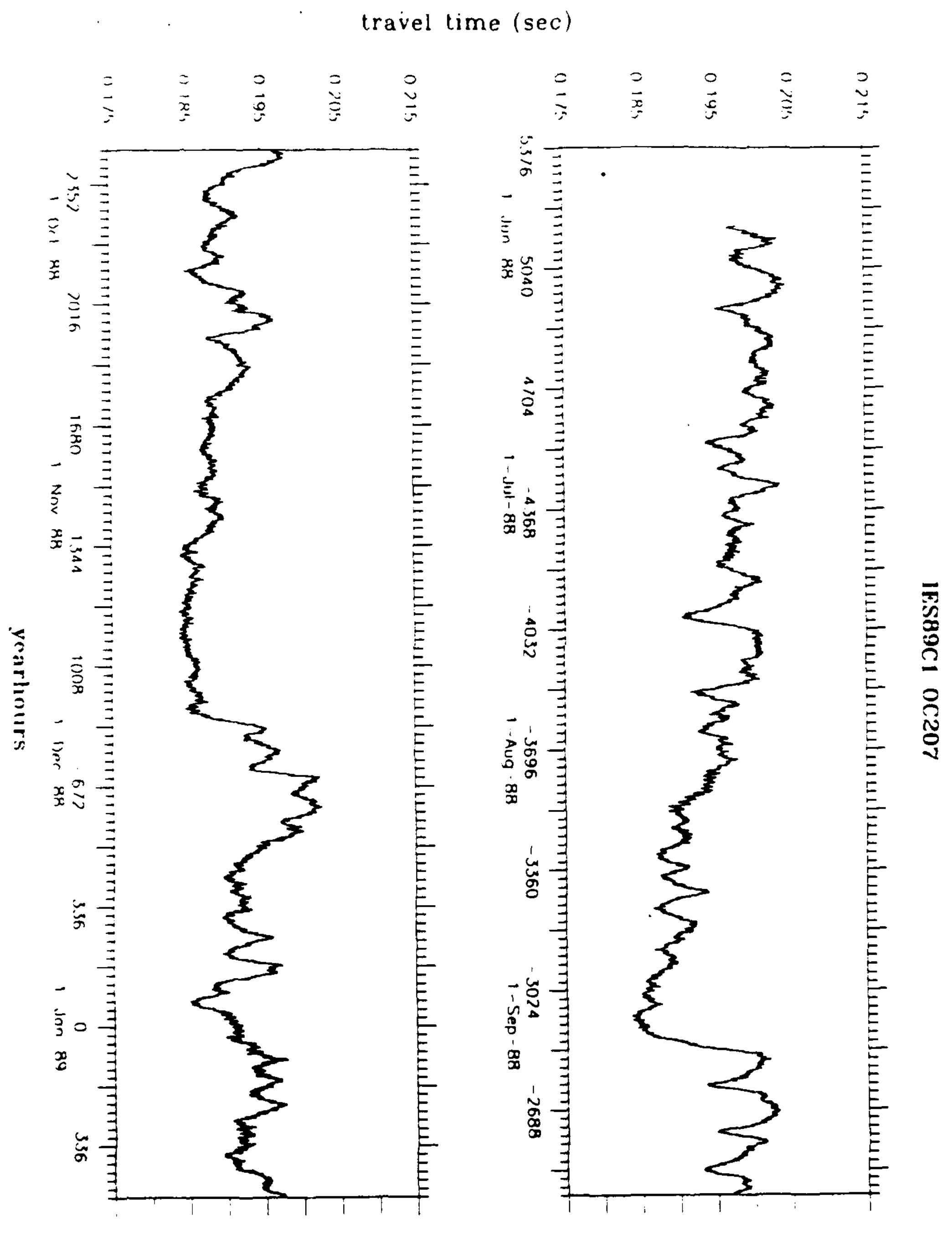
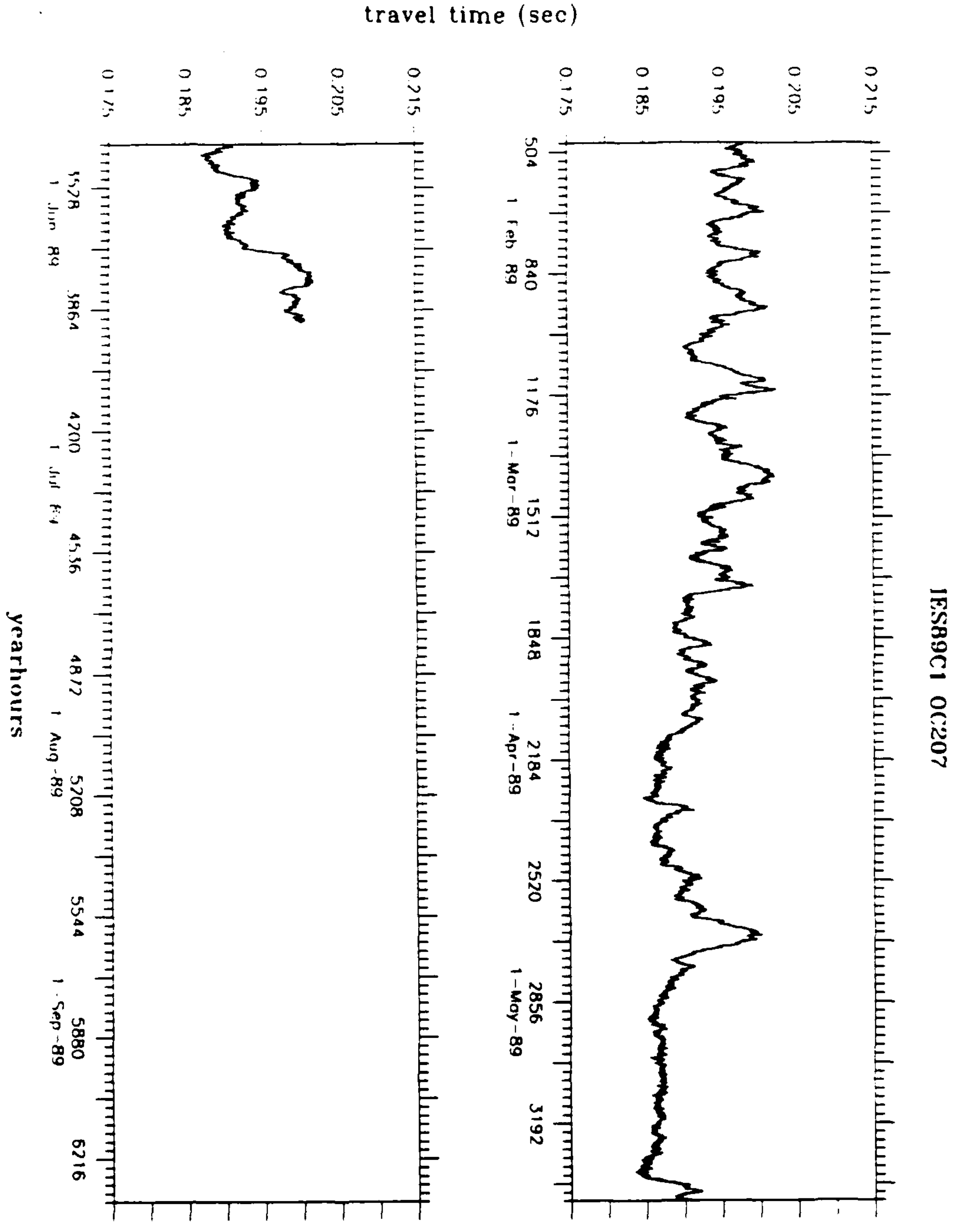


Figure 6.8: Half-Hourly Travel Times. IES89C1_207


IES89C1 0C207
travel time (sec)
0.175
0.185
0.195
0.205
0.215
504
840
1 Feb 89
1176
1-Mar-89
1512
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1 Jun 89
3864
4200
1 Jul 89
4536
4872
1 Aug-89
5208
5544
1 Sep-89
5880
6216
yearhours

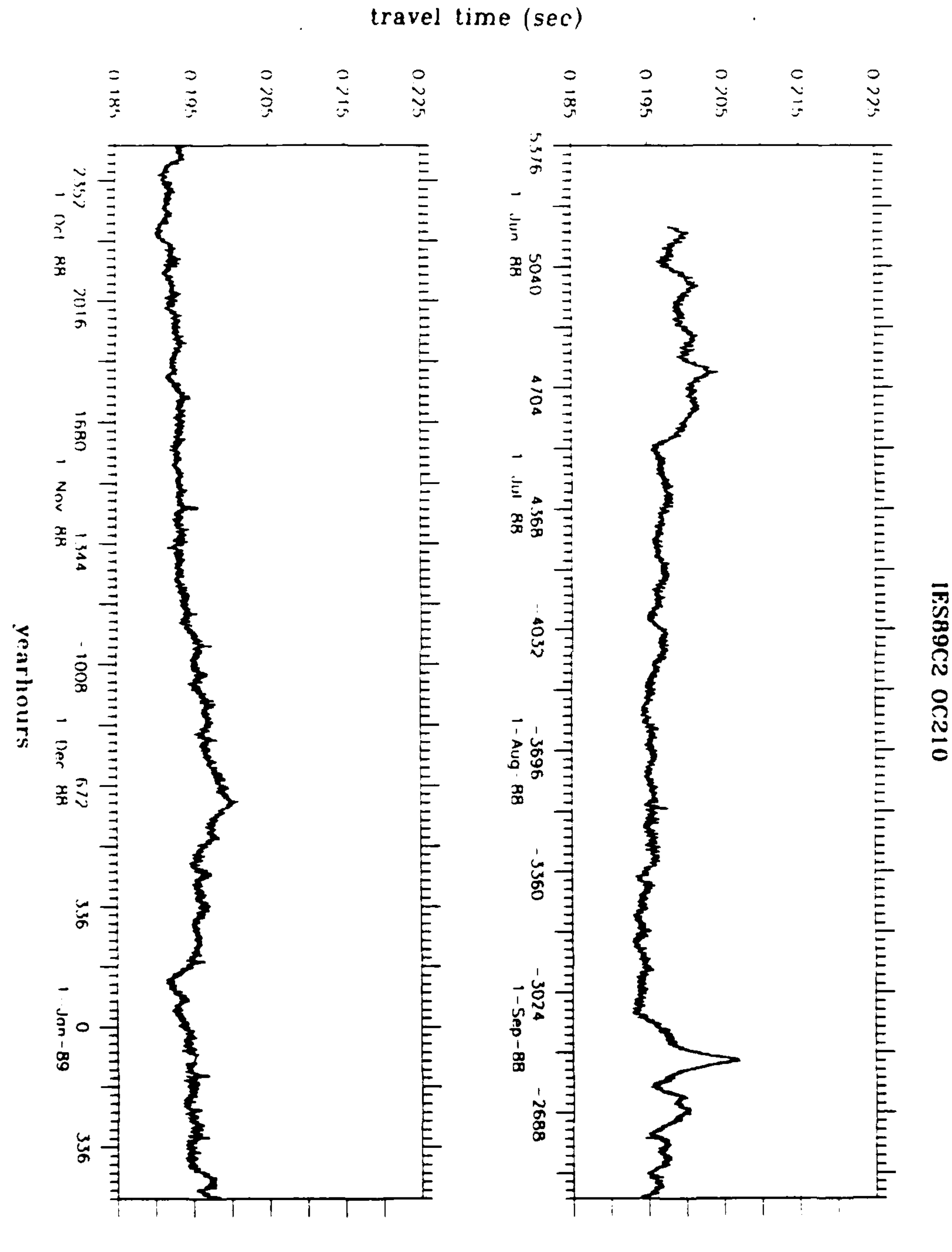
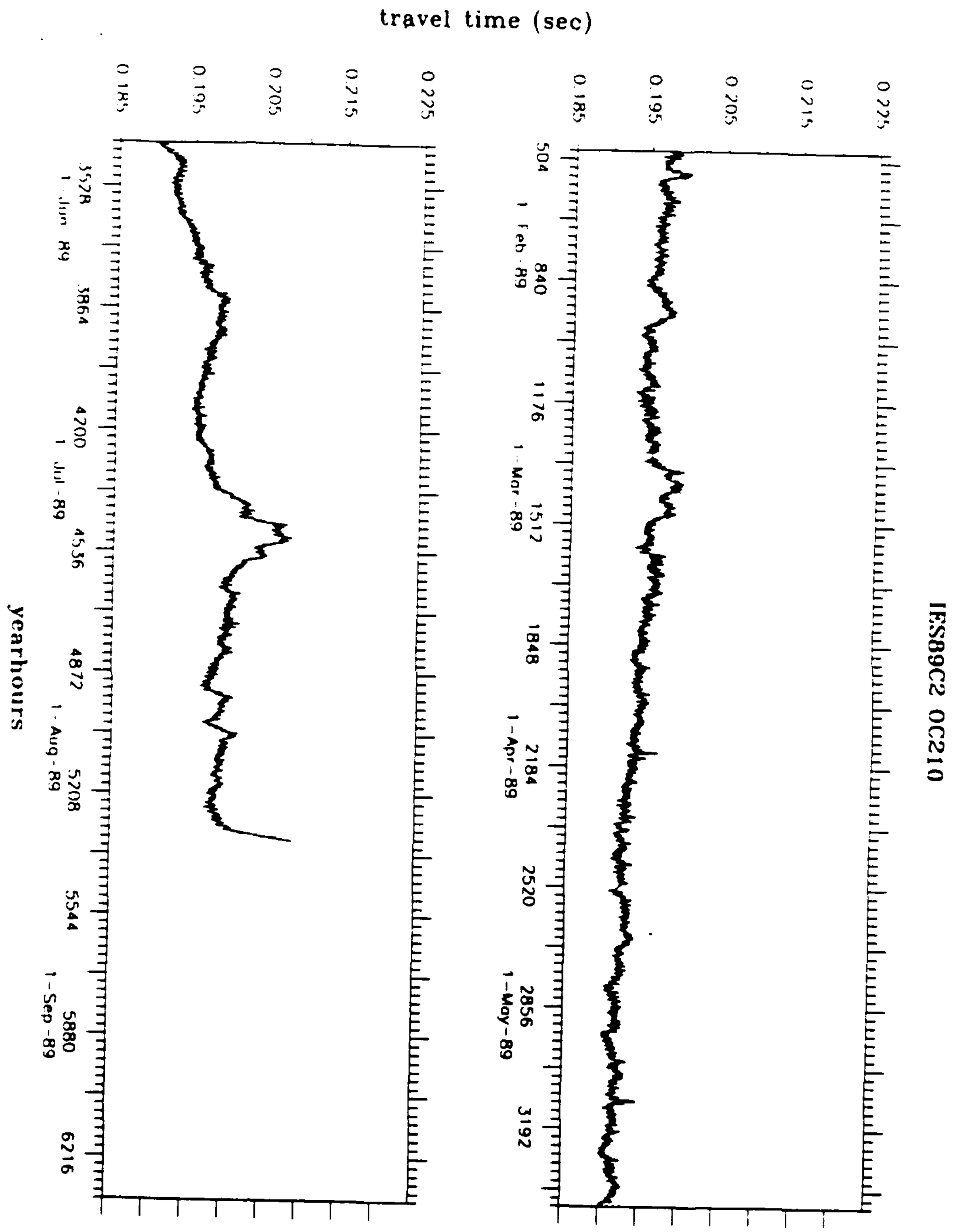


Figure 6.9: Half-Hourly Travel Times. IES89C2_210


IES89C2 0C210
travel time (sec)
0.225
0.215
0.205
0.195
0.185
504
840
1 Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

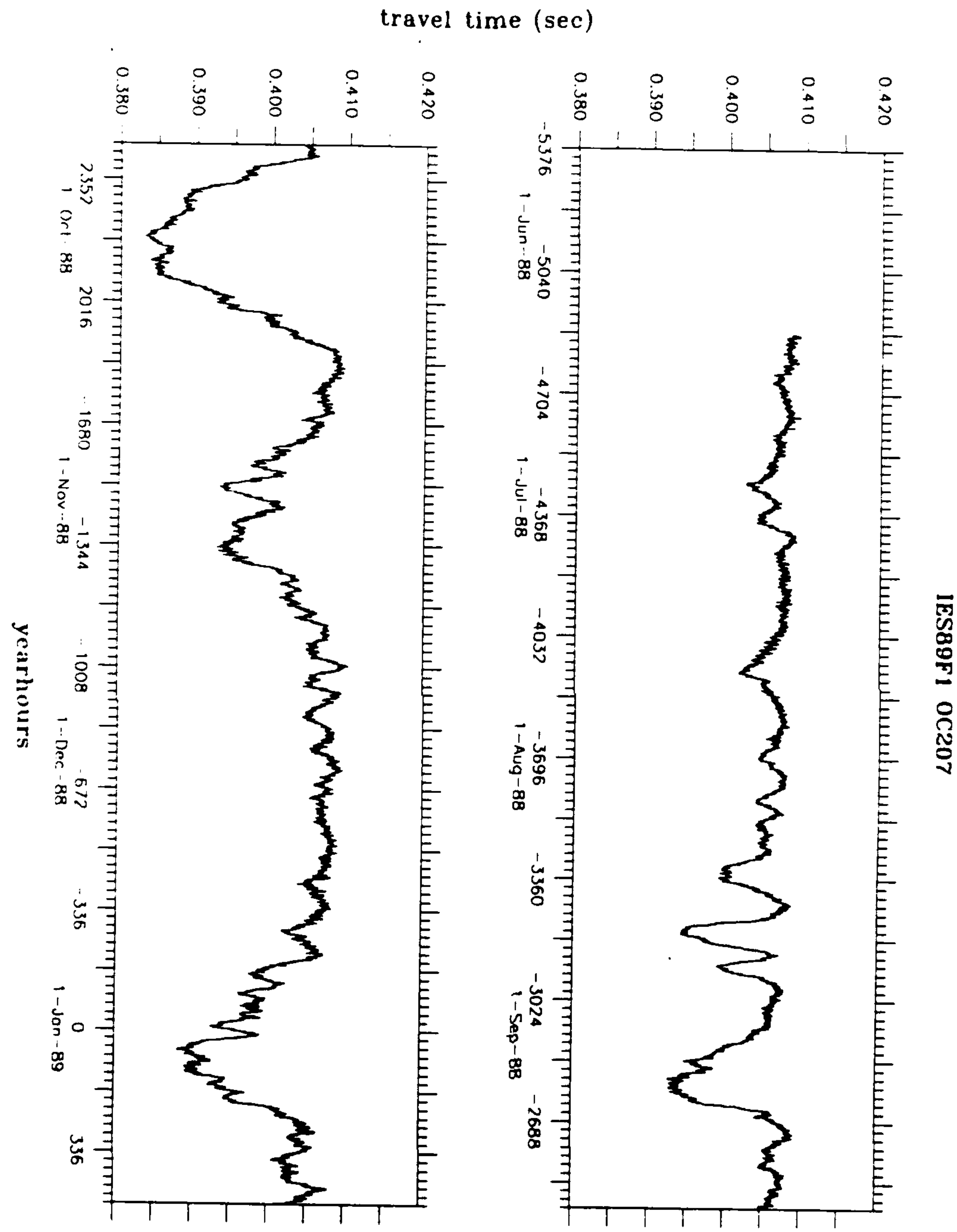
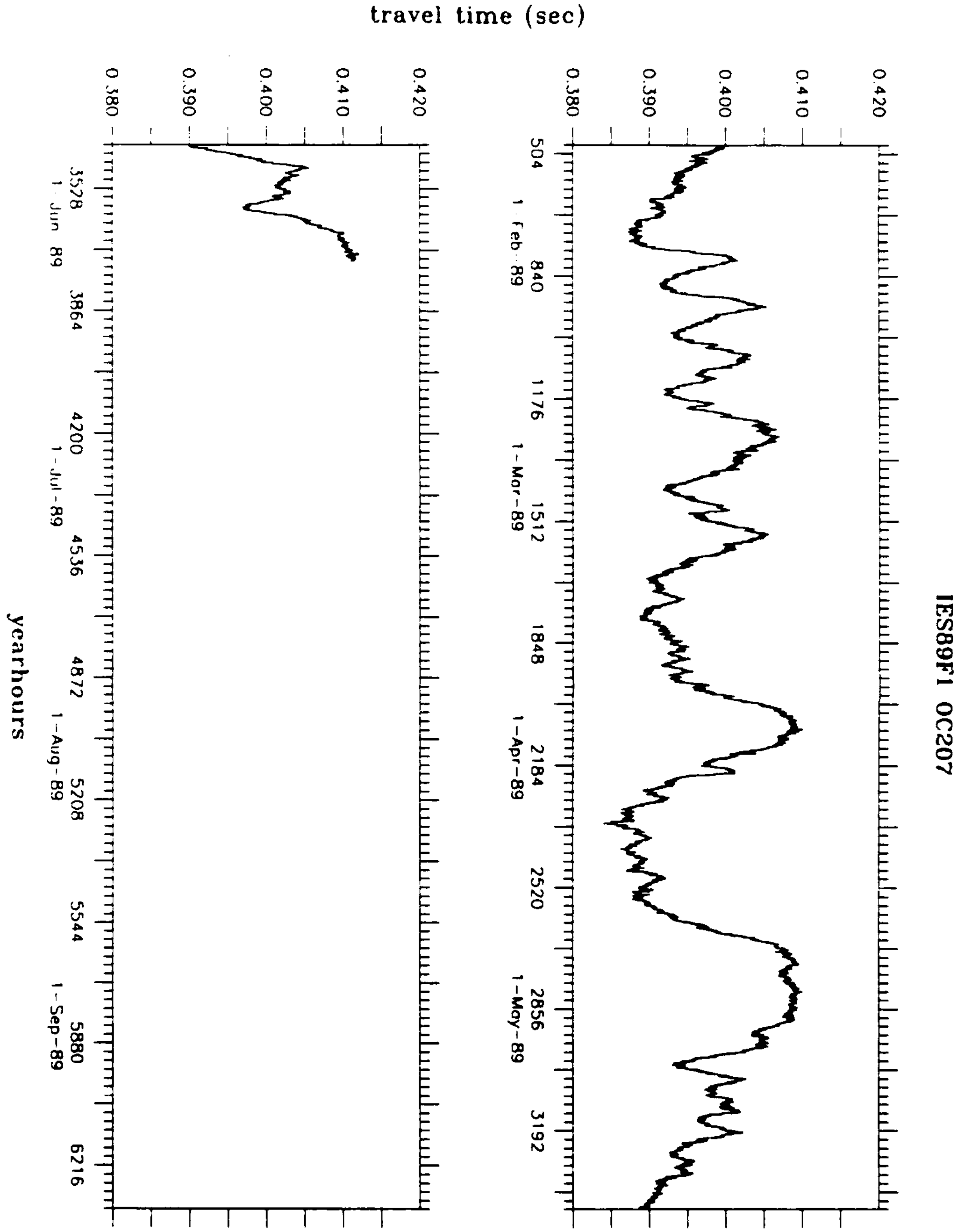


Figure 6.10: Half-Hourly Travel Times. IES89F1_207


IES89F1 OC207
travel time (sec)
0.380
0.390
0.400
0.410
0.420
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

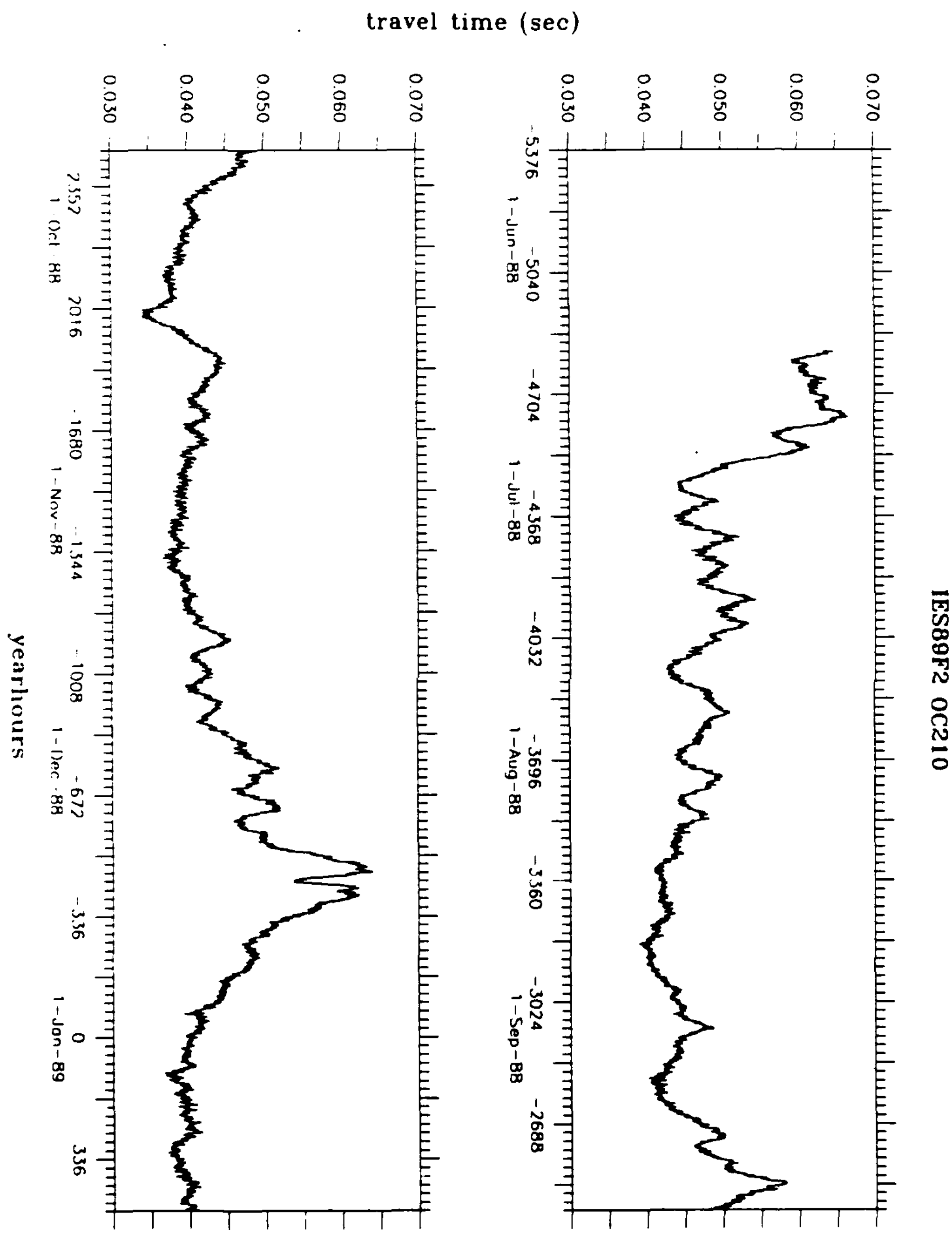
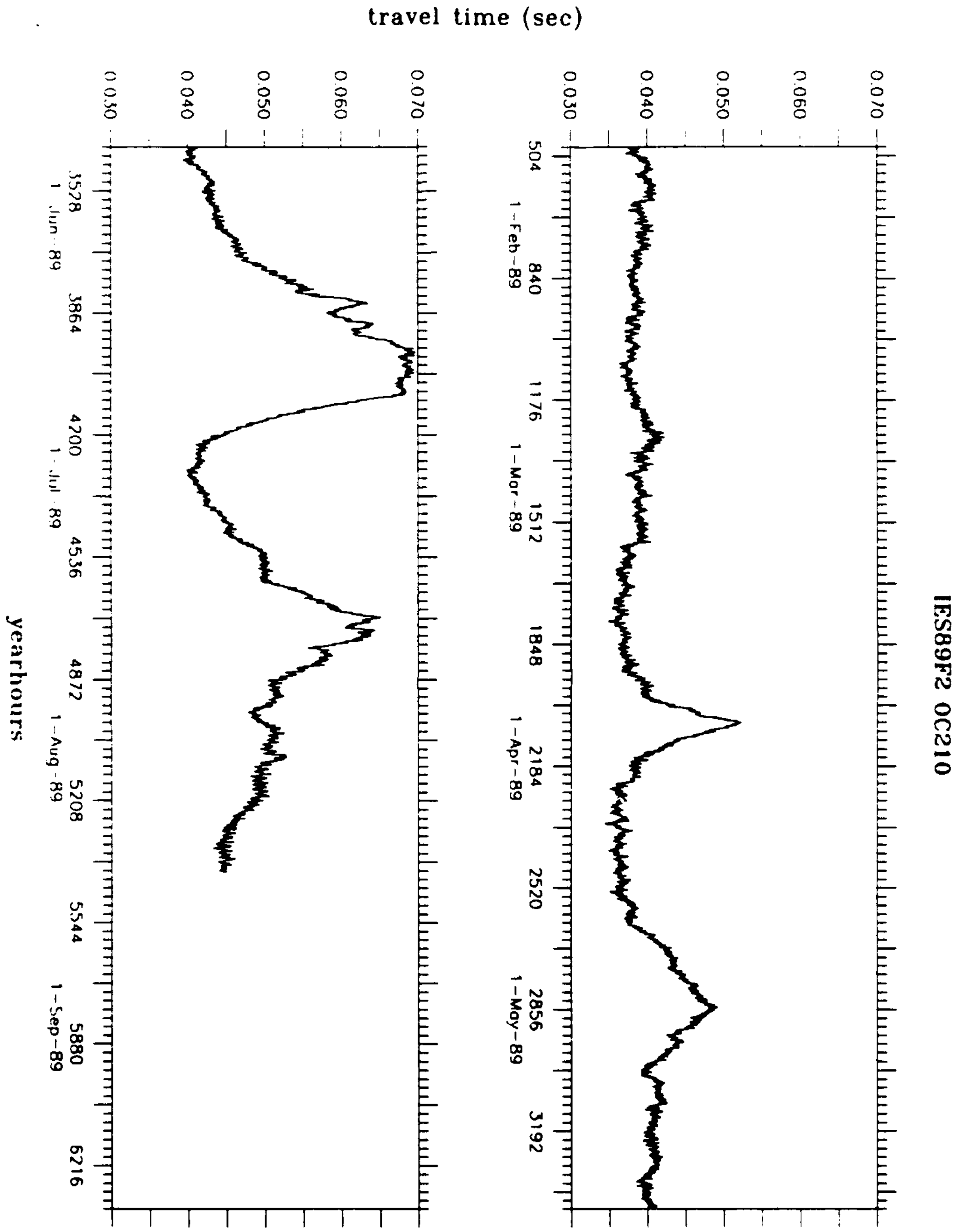


Figure 6.11: Half-Hourly Travel Times. IES89F2_210



IES89F2 OC210
travel time (sec)
0.030
0.040
0.050
0.060
0.070
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

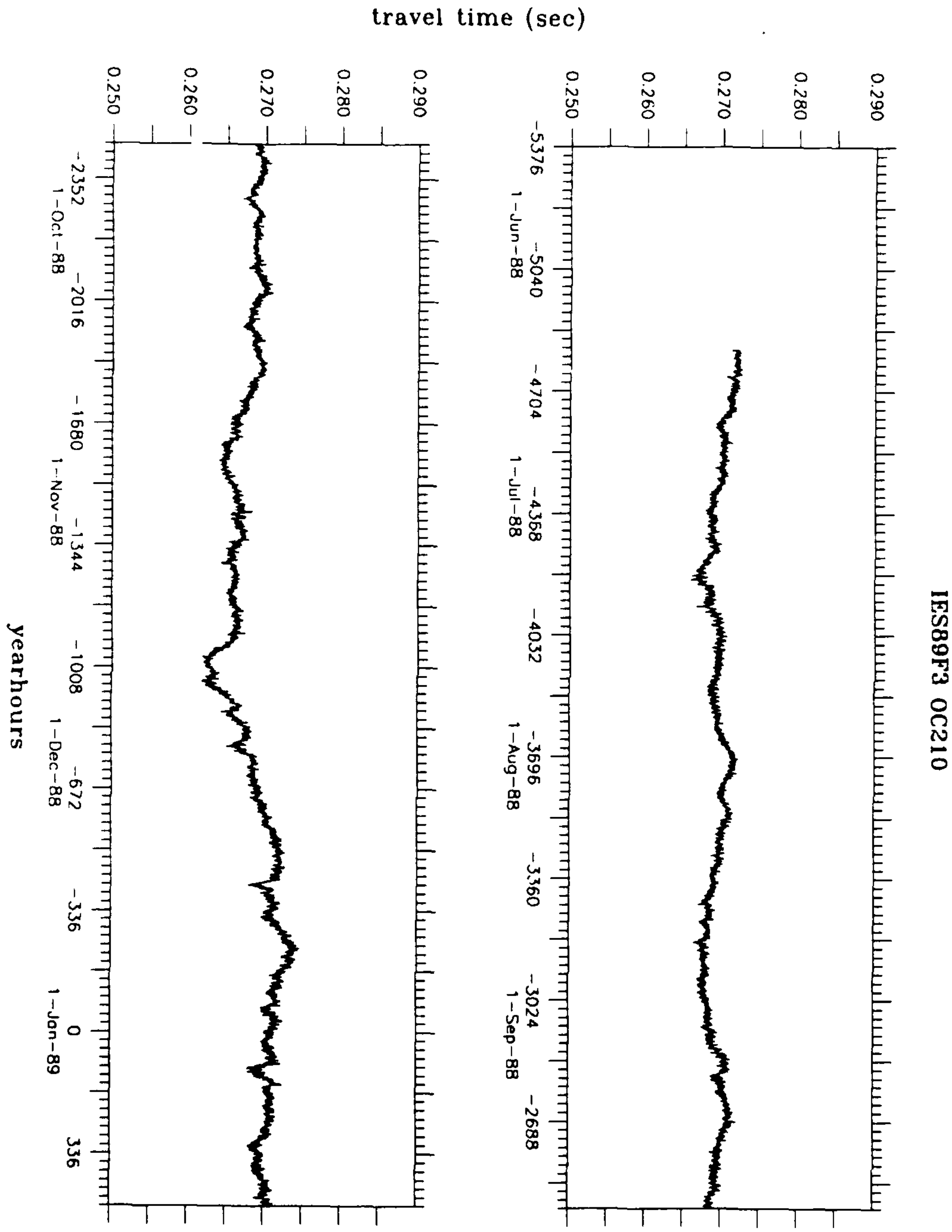
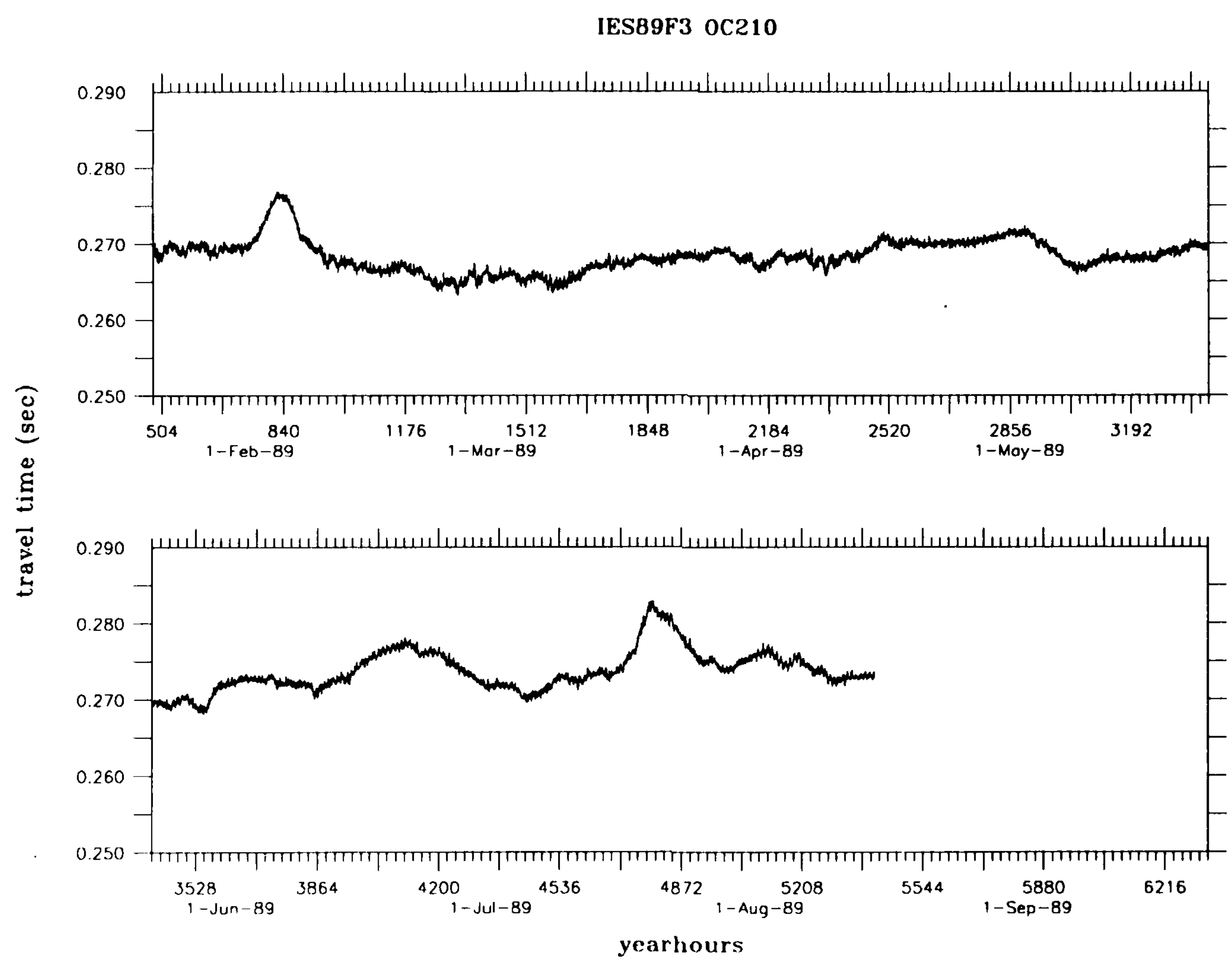


Figure 6.12: Half-Hourly Travel Times. IES89F3_210


IES89F3 OC210
travel time (sec)
0.250
0.260
0.270
0.280
0.290
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

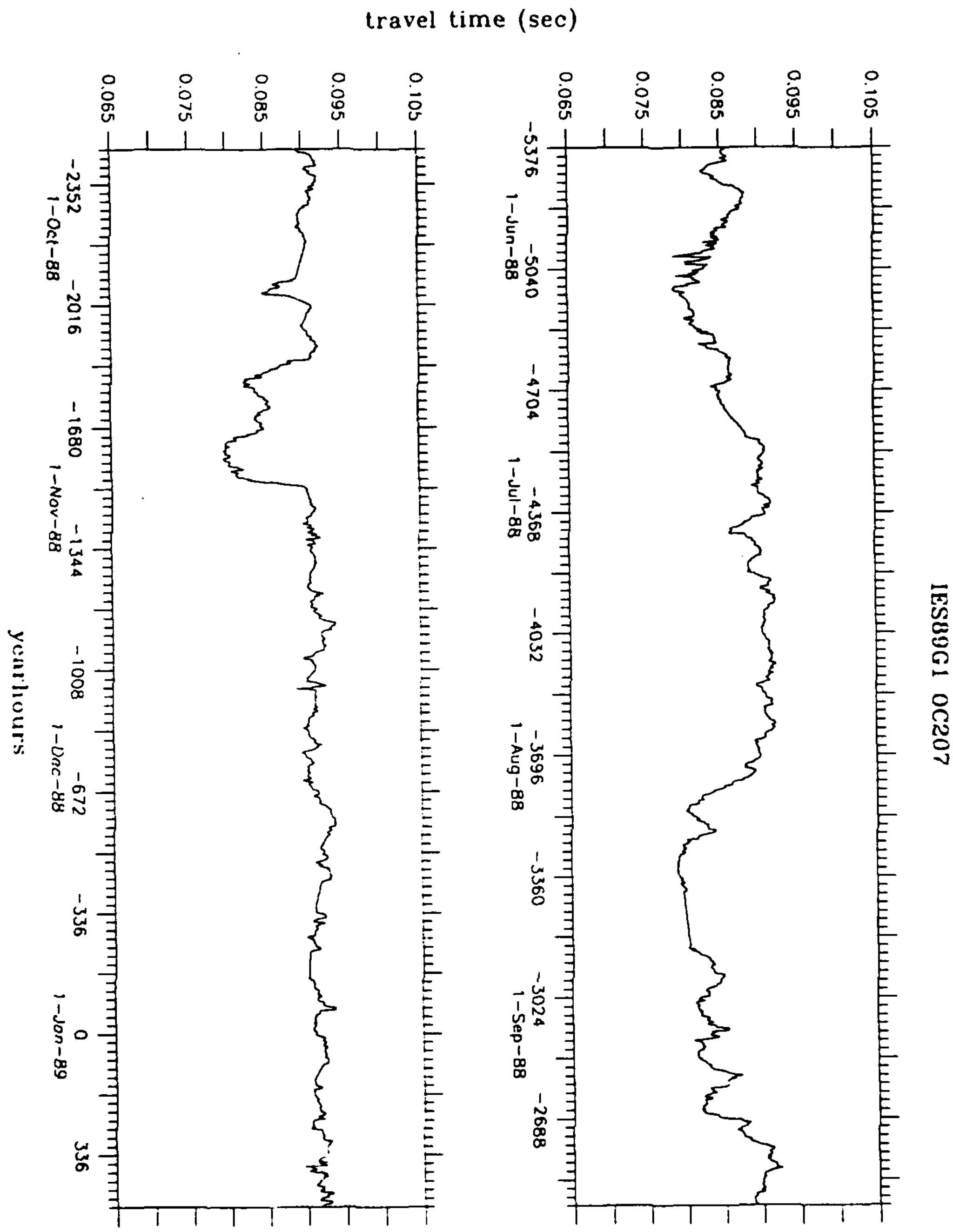
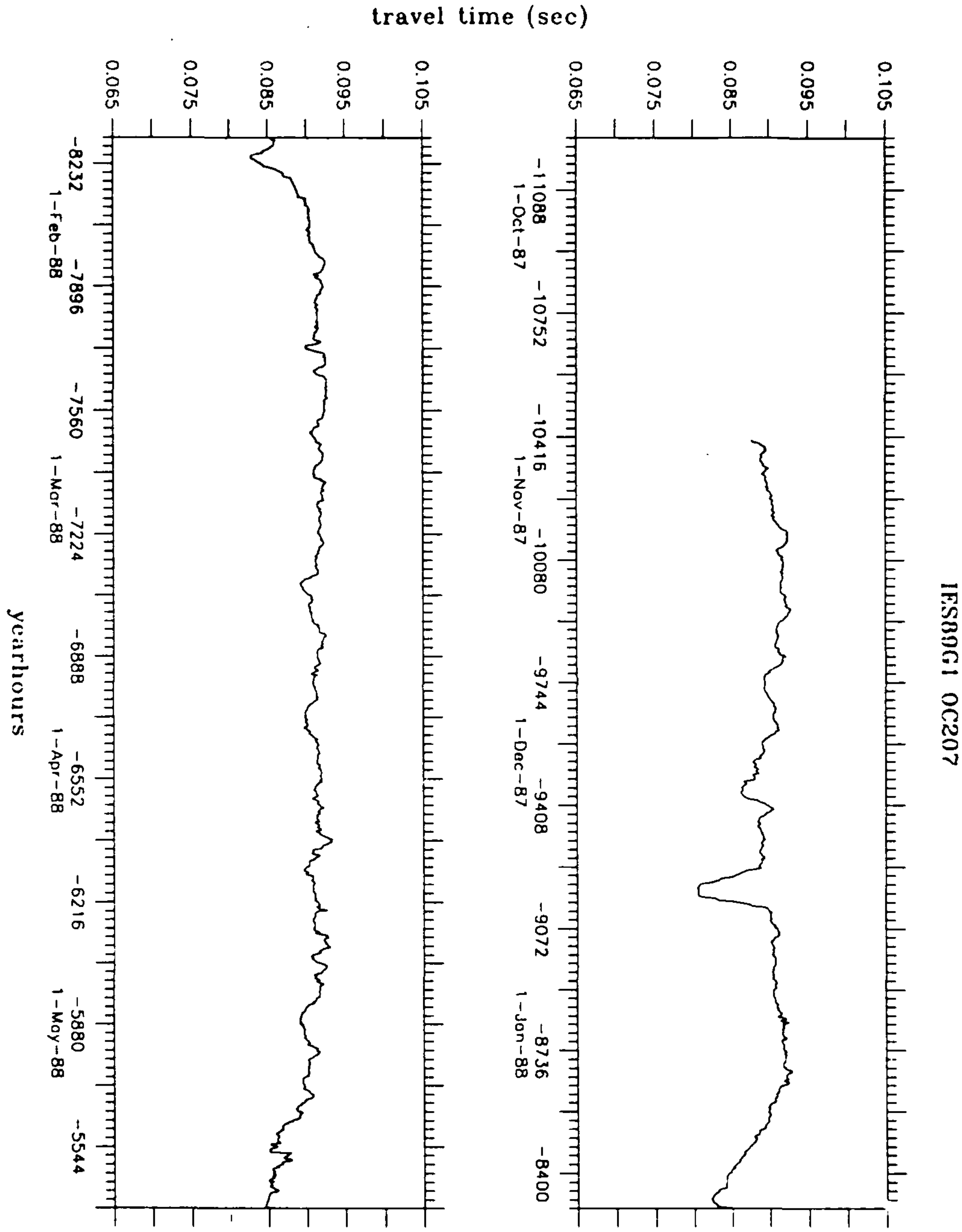
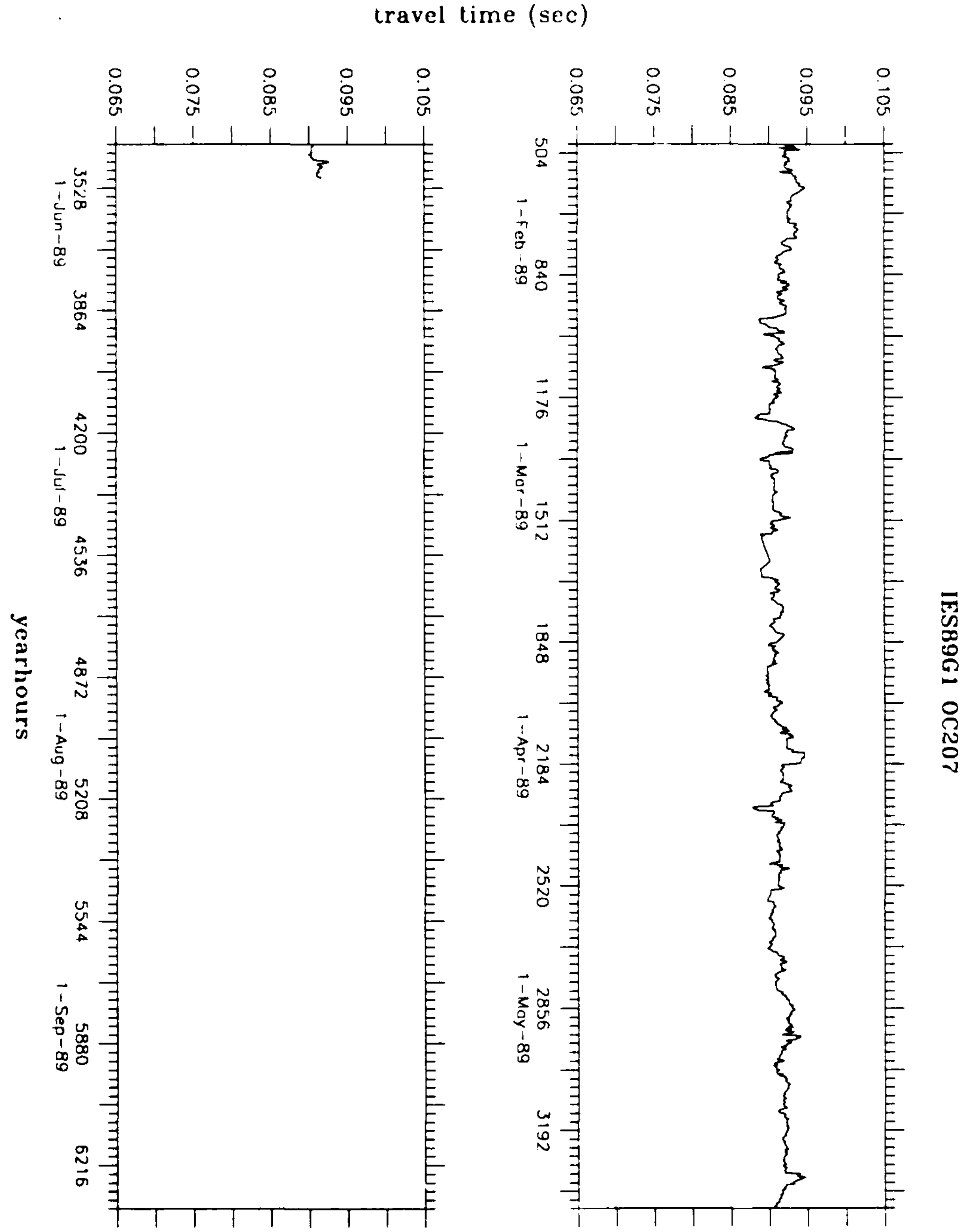


Figure 6.13: Half-Hourly Travel Times. IES89G1_207


IES89G1 OC207
travel time (sec)
0.105
0.095
0.085
0.075
0.065
-11088
1-Oct-87
-10752
-10416
1-Nov-87
-10080
-9744
1-Dec-87
-9408
-9072
1-Jan-88
-8736
-8400
-8232
1-Feb-88
-7896
-7560
1-Mar-88
-7224
-6888
1-Apr-88
-6552
-6216
1-May-88
-5880
-5544
yearhours


IES89G1 OC207
travel time (sec)
yearhours
0.065
0.075
0.085
0.095
0.105
504
840
1 -Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216

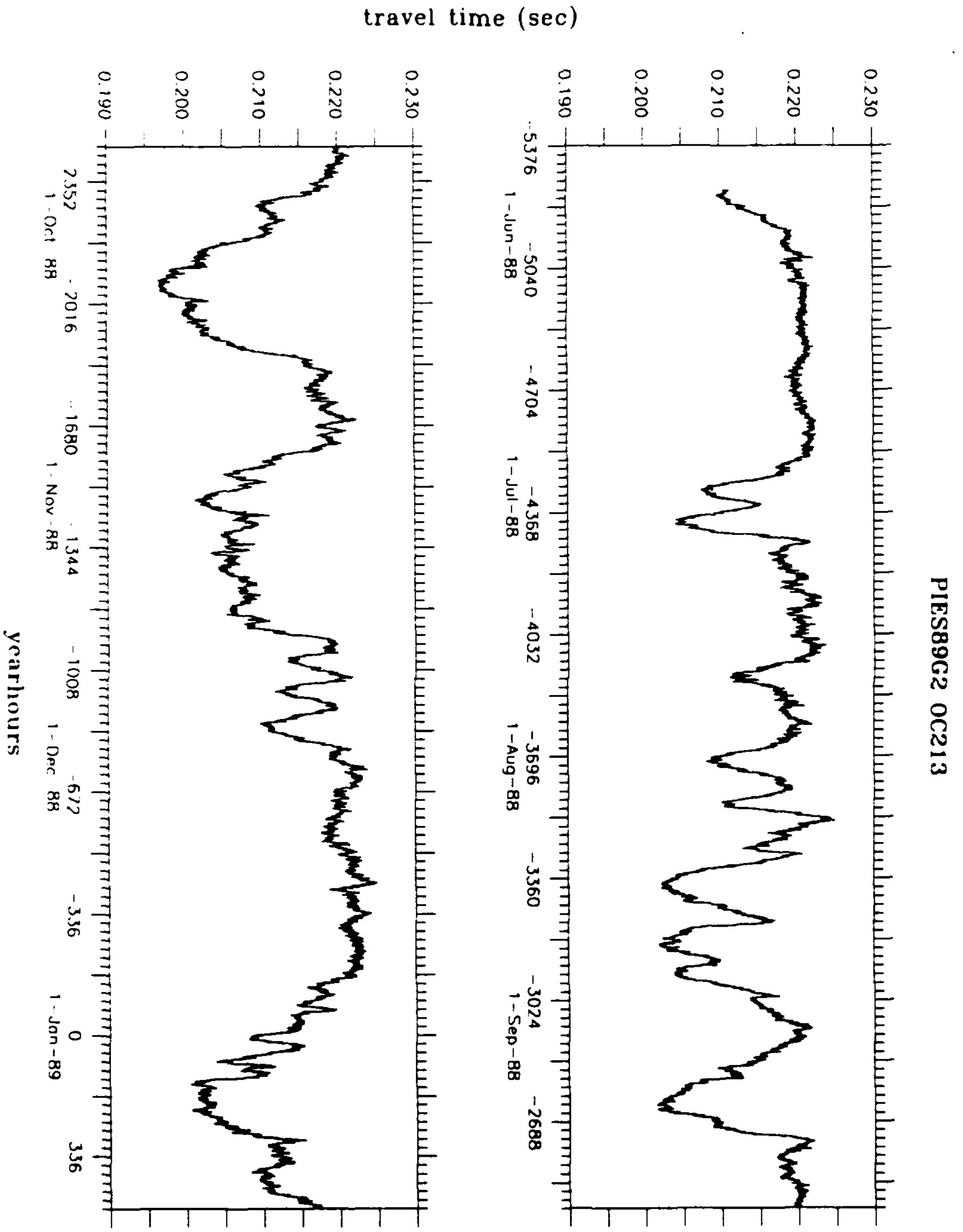
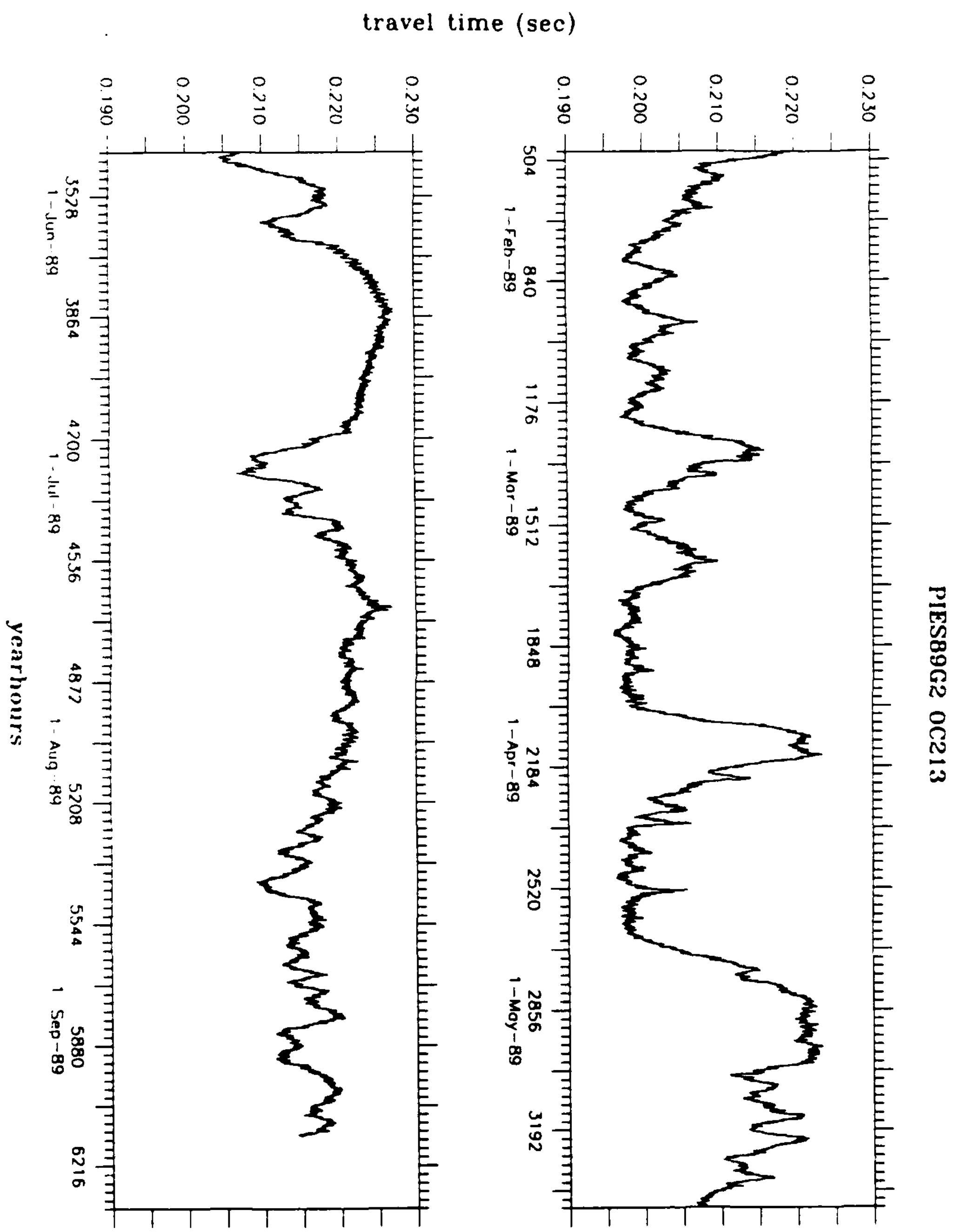


Figure 6.14: Half-Hourly Travel Times. PIES89G2_213


PIES89G2 OC213
travel time (sec)
0.190
0.200
0.210
0.220
0.230
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

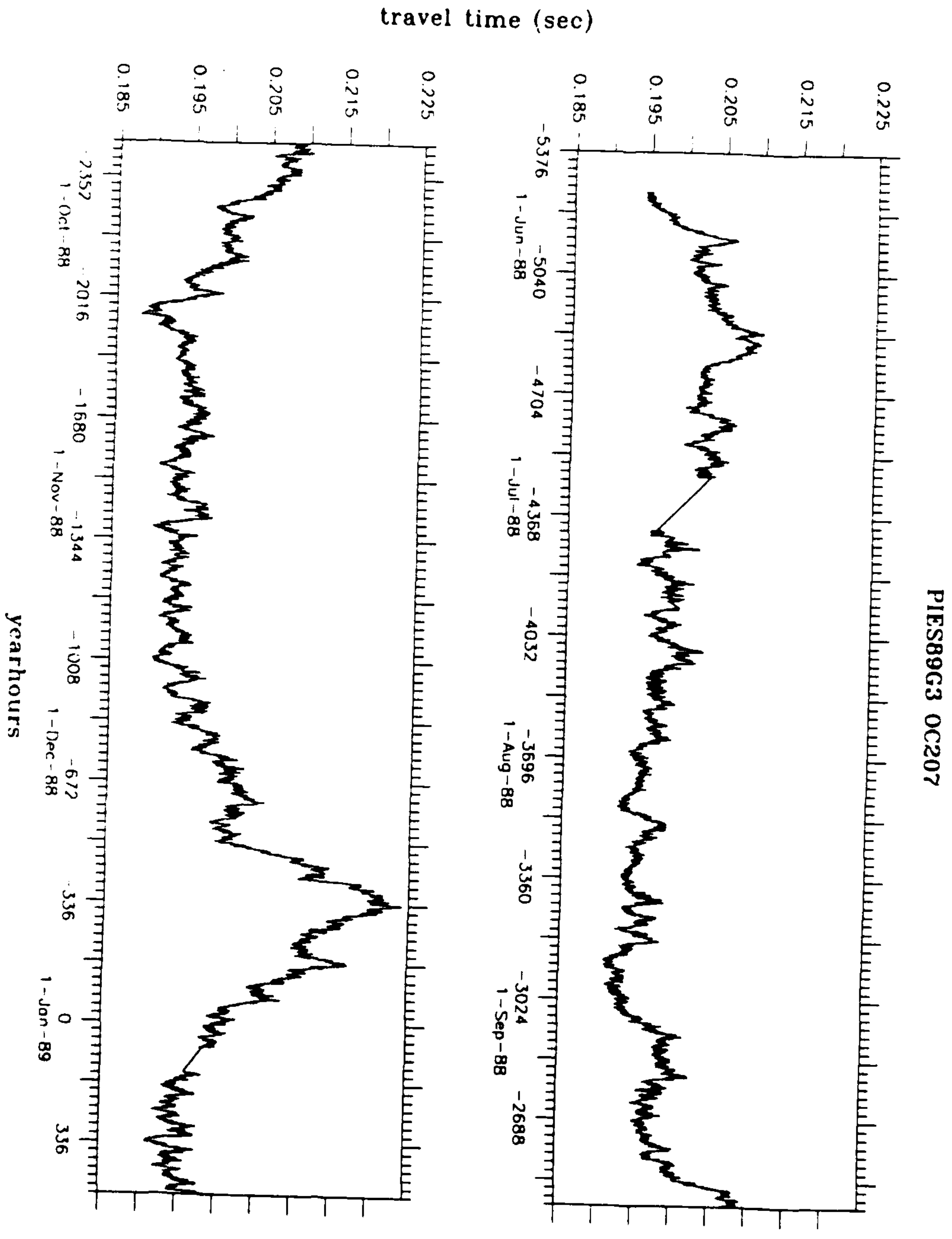
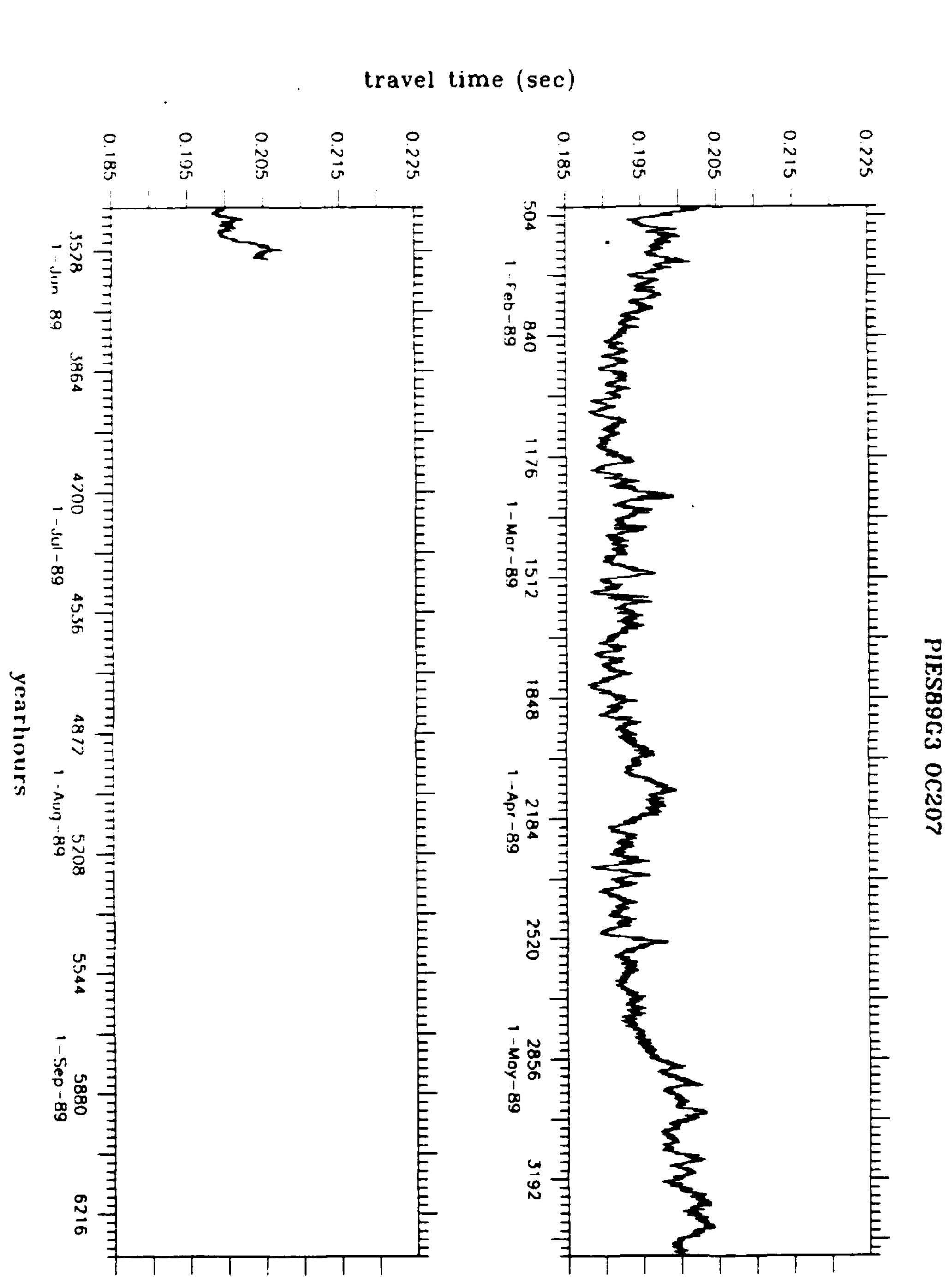


Figure 6.15: Half-Hourly Travel Times. PIES89G3_207


PIES89G3 OC207
travel time (sec)
0.225
0.215
0.205
0.195
0.185
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

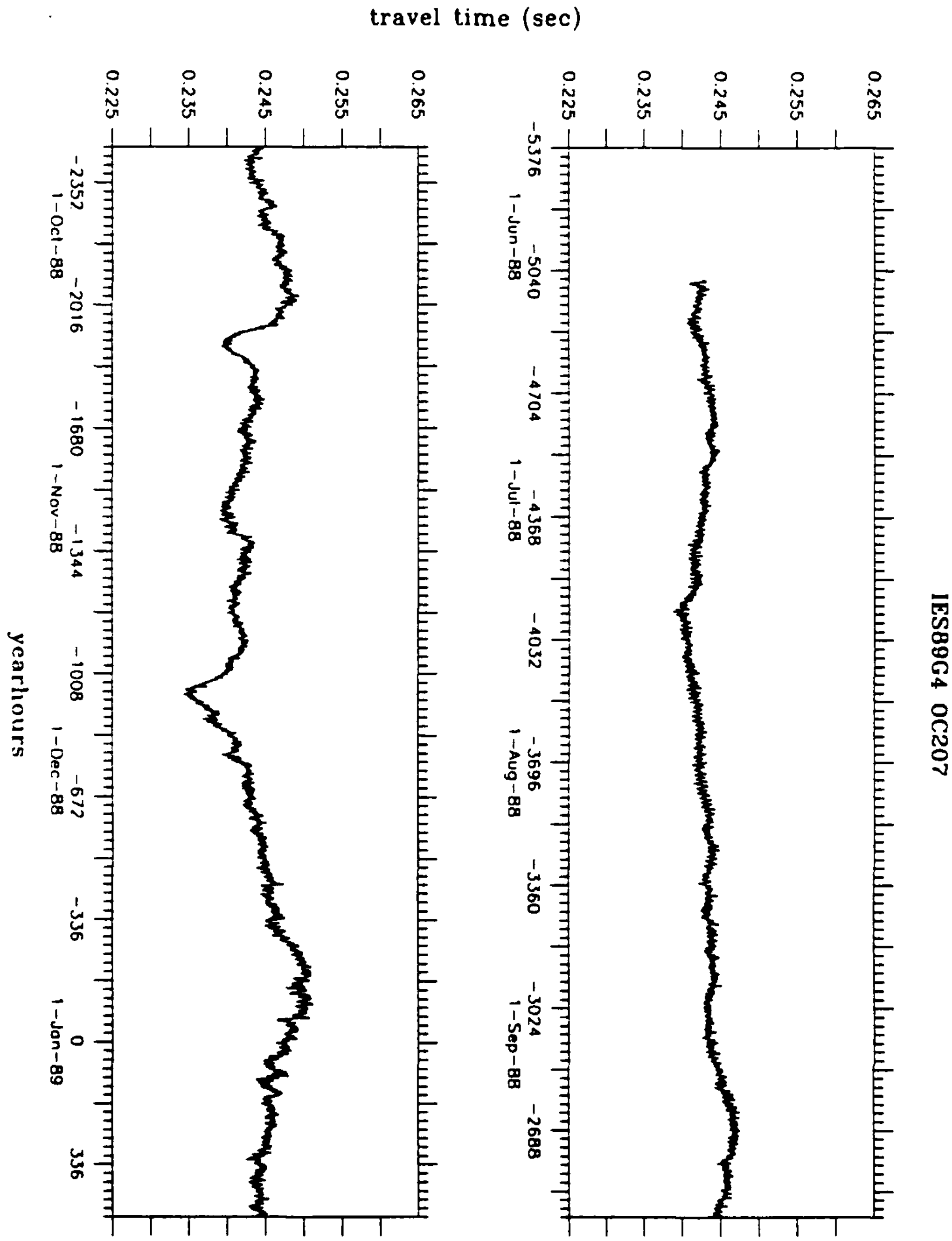
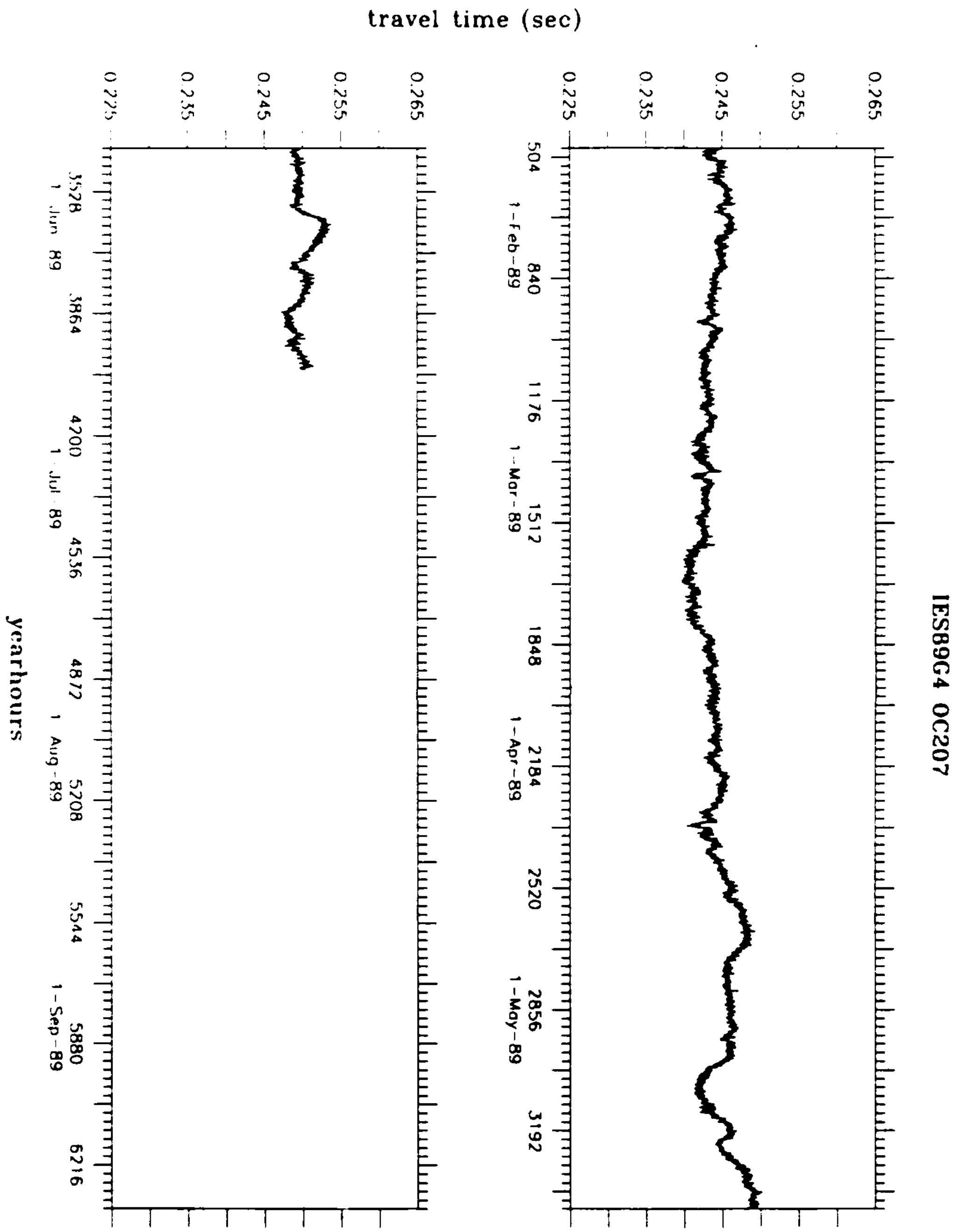


Figure 6.16: Half-Hourly Travel Times. IES89G4_207



IES89G4 0C207
travel time (sec)
0.225
0.235
0.245
0.255
0.265
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1 Jun 89
3864
4200
1 Jul 89
4536
4872
1 Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

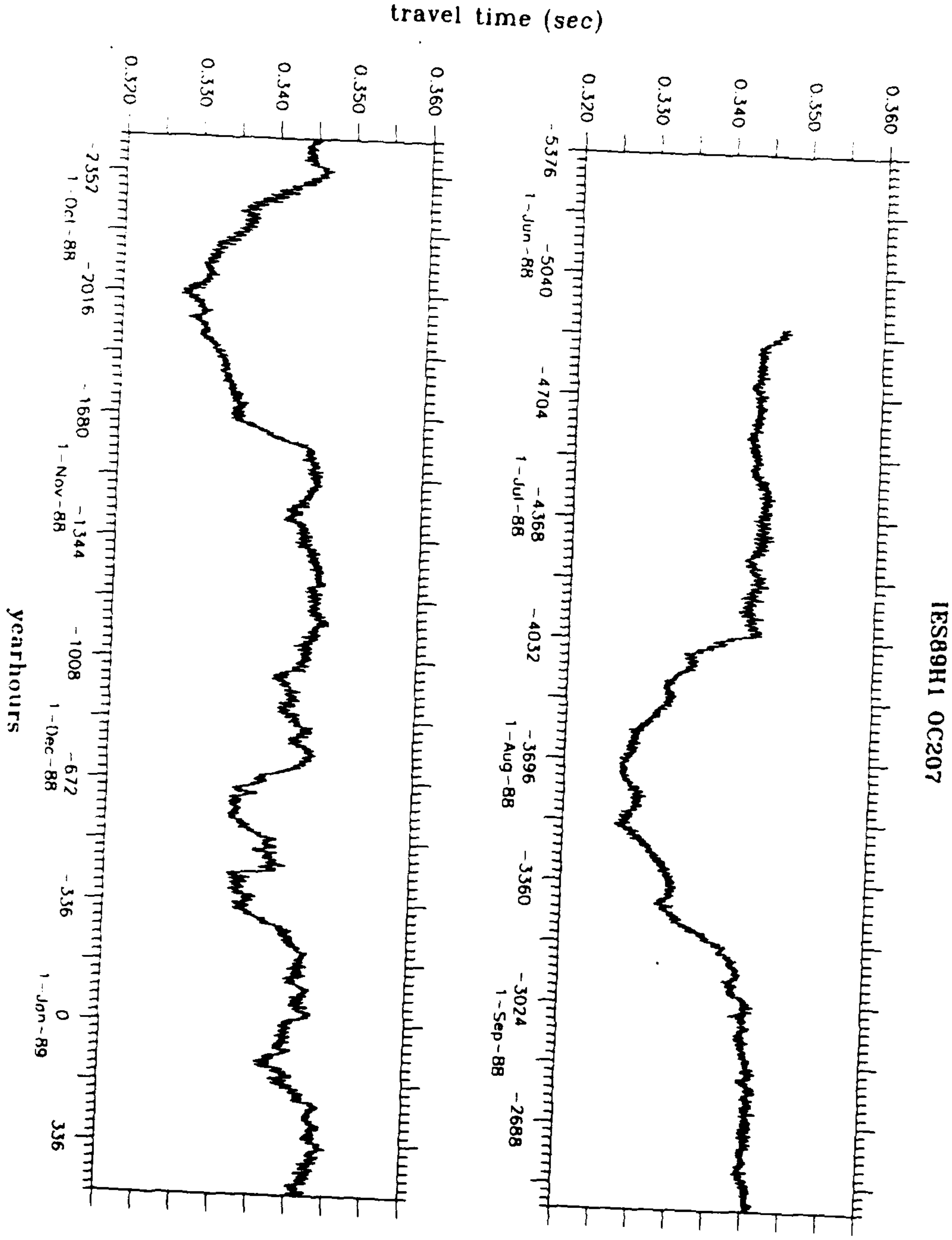
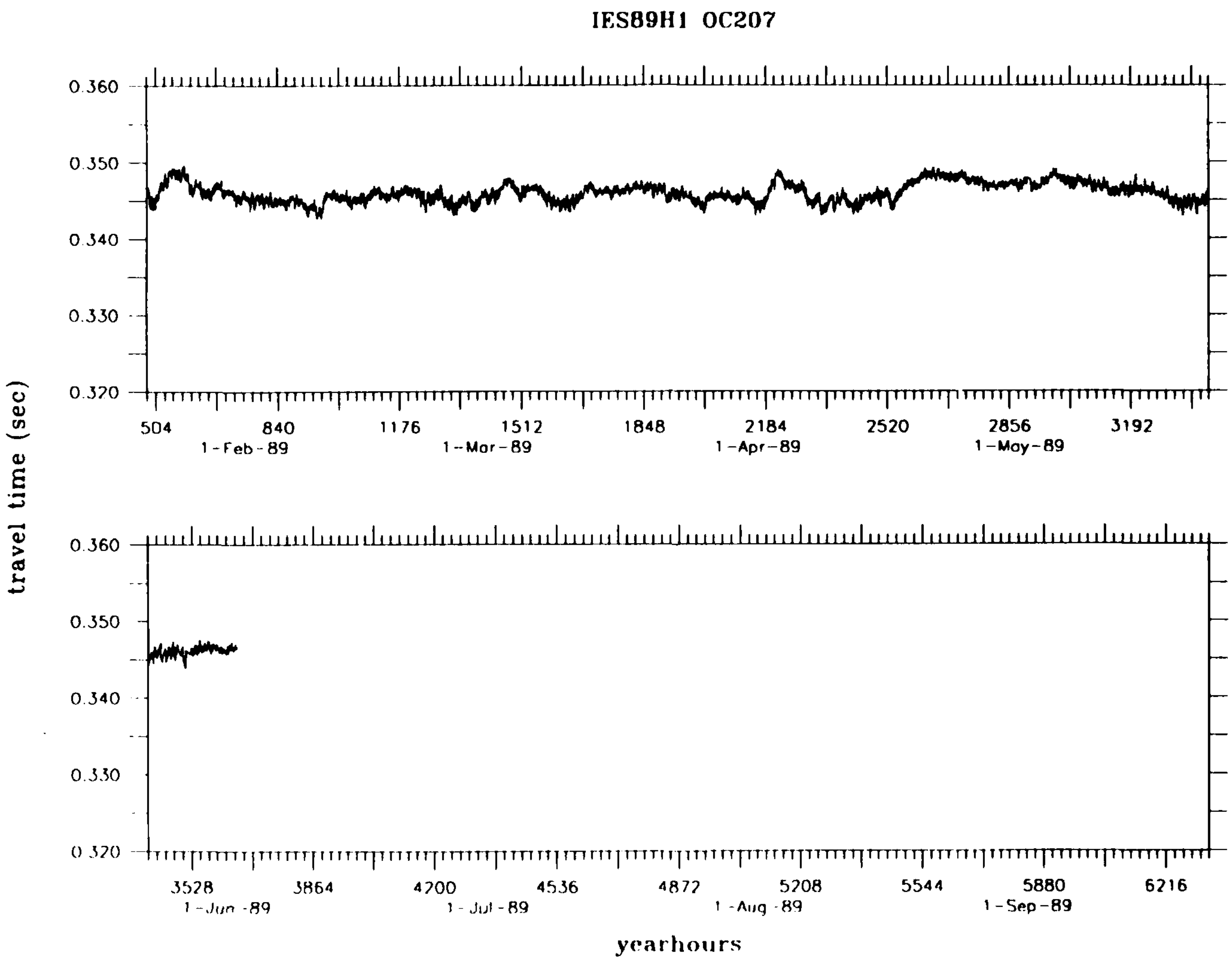


Figure 6.17: Half-Hourly Travel Times. IES89H1_207


IES89H1 OC207
travel time (sec)
0.360
0.350
0.340
0.330
0.320
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

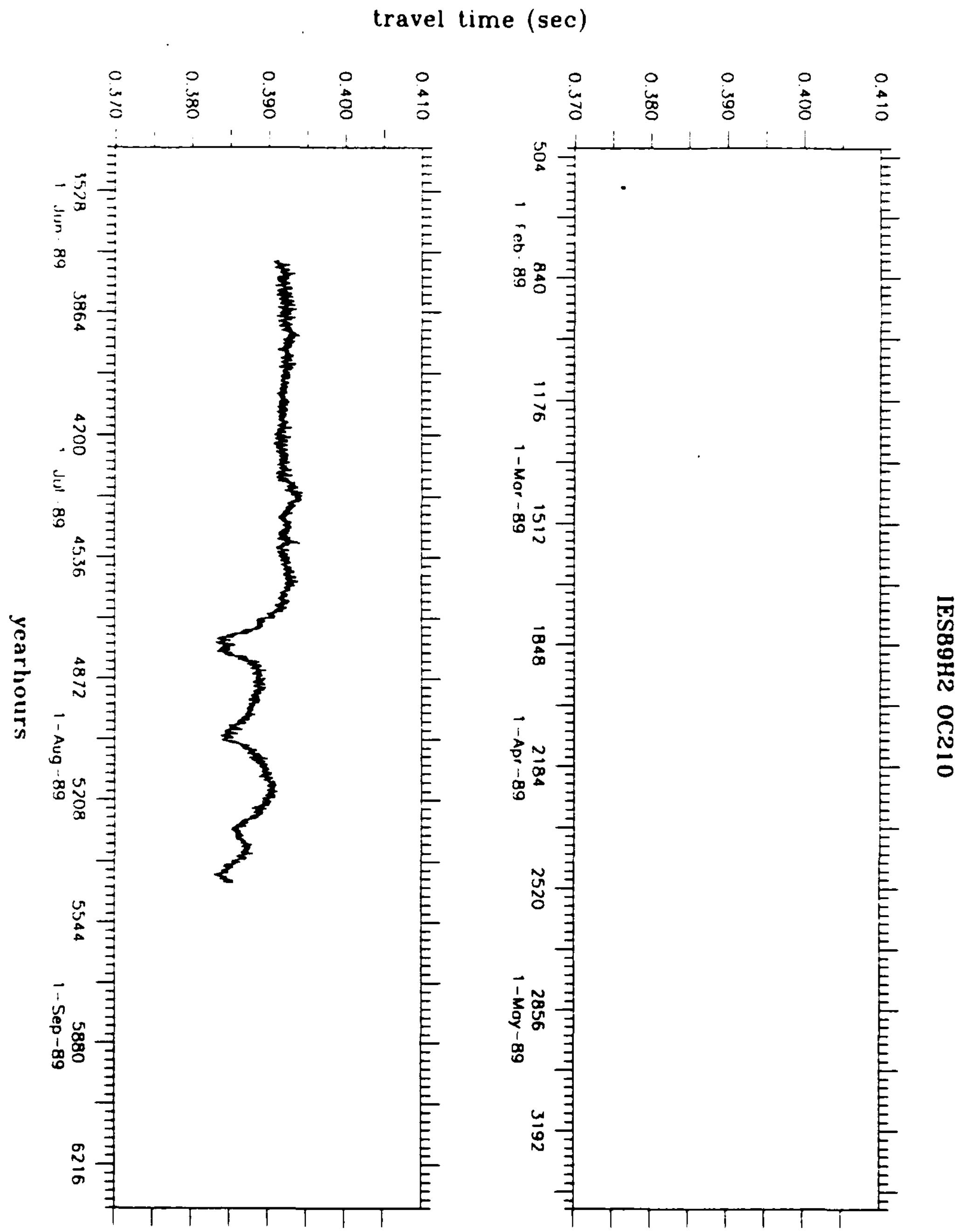


Figure 6.18: Half-Hourly Travel Times. IES89H2_210

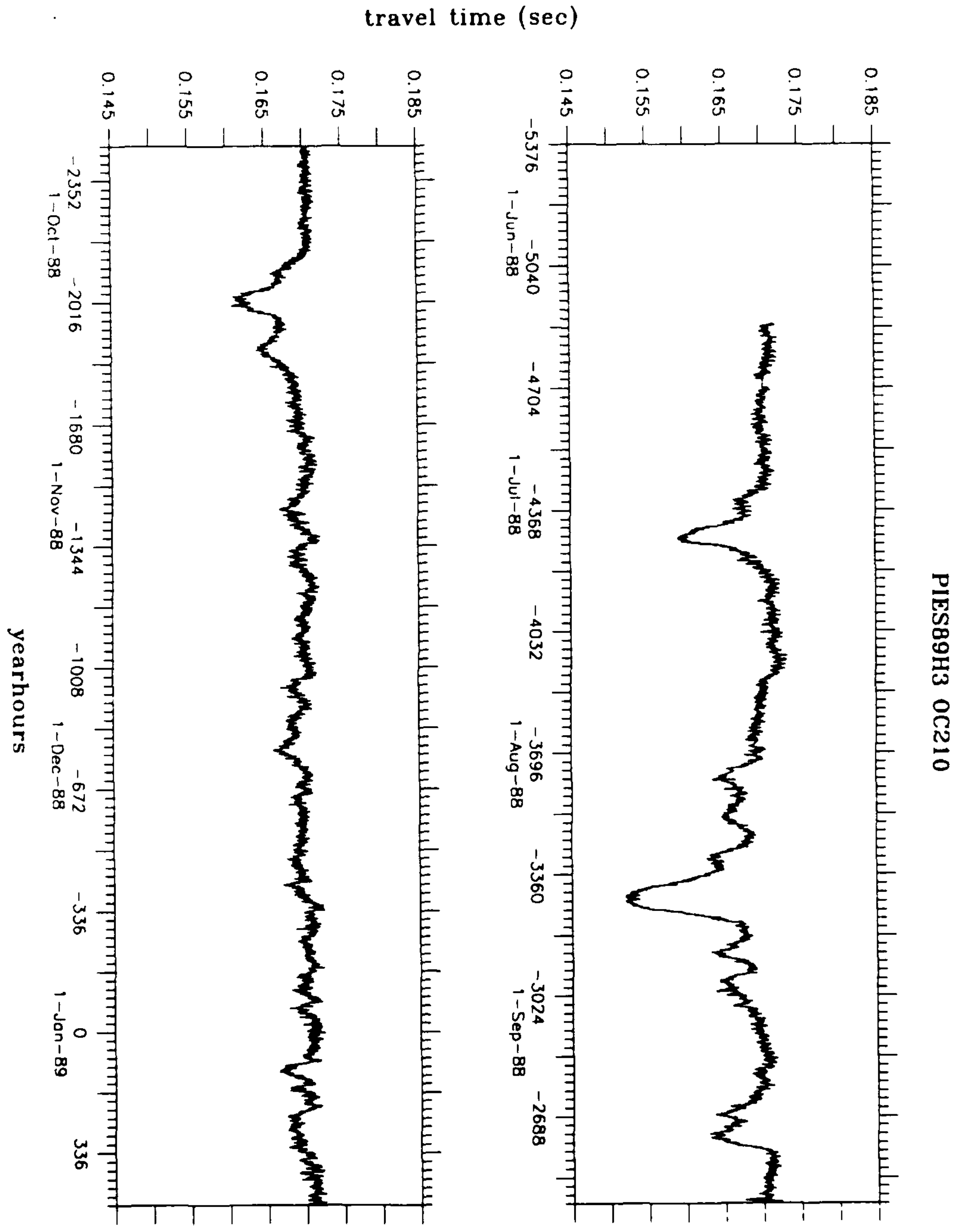
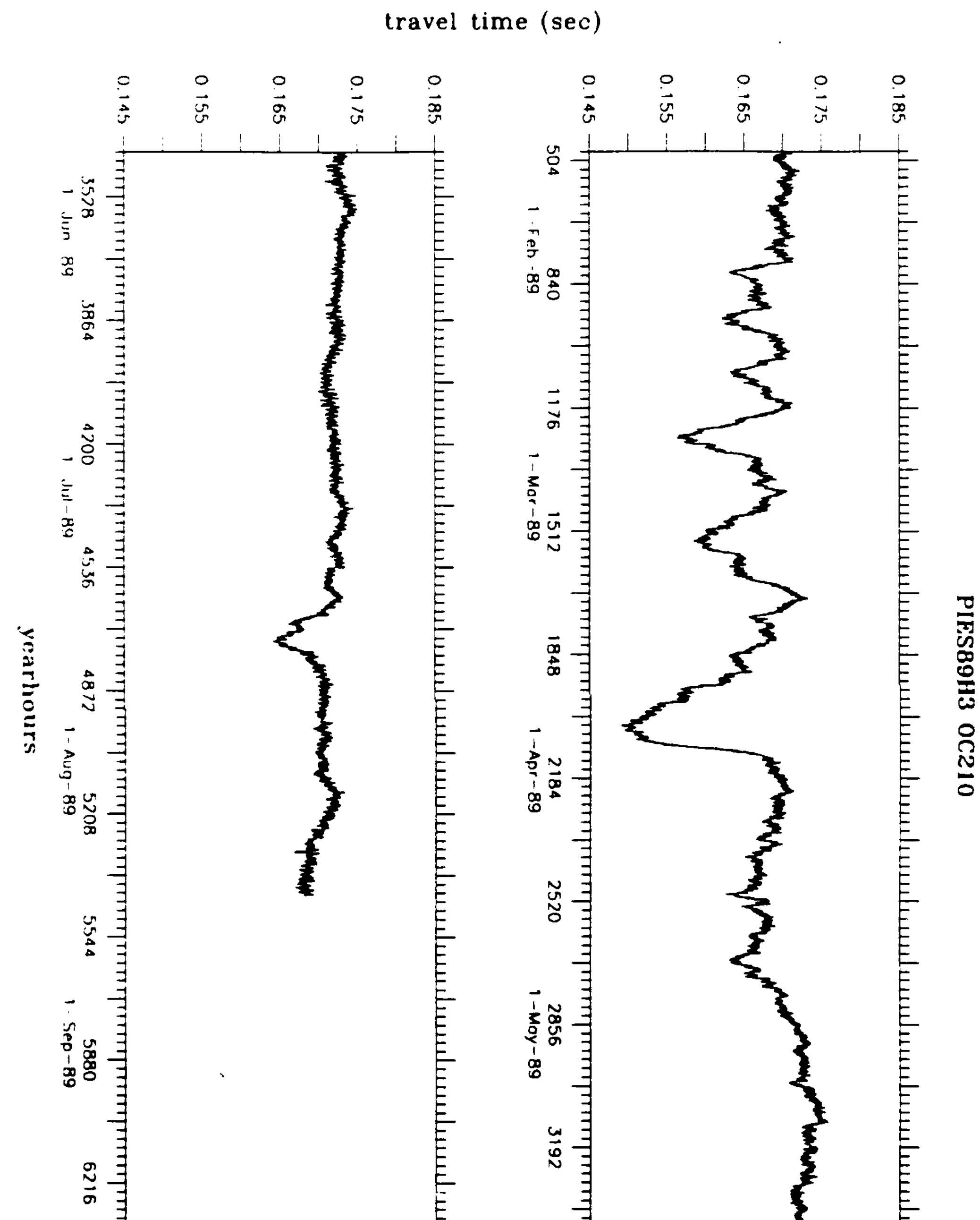


Figure 6.19: Half-Hourly Travel Times. PIES89H3_210


PIES89H3 OC210
travel time (sec)
0.145
0.155
0.165
0.175
0.185
504
840
1 -Feb -89
1176
1512
1 -Mar-89
1848
2184
1 -Apr-89
2520
2856
1 -May-89
3192
3528
1 Jun 89
3864
4200
1 Jul-89
4536
4872
1 -Aug-89
5208
5544
5880
1 Sep-89
6216
yearhours

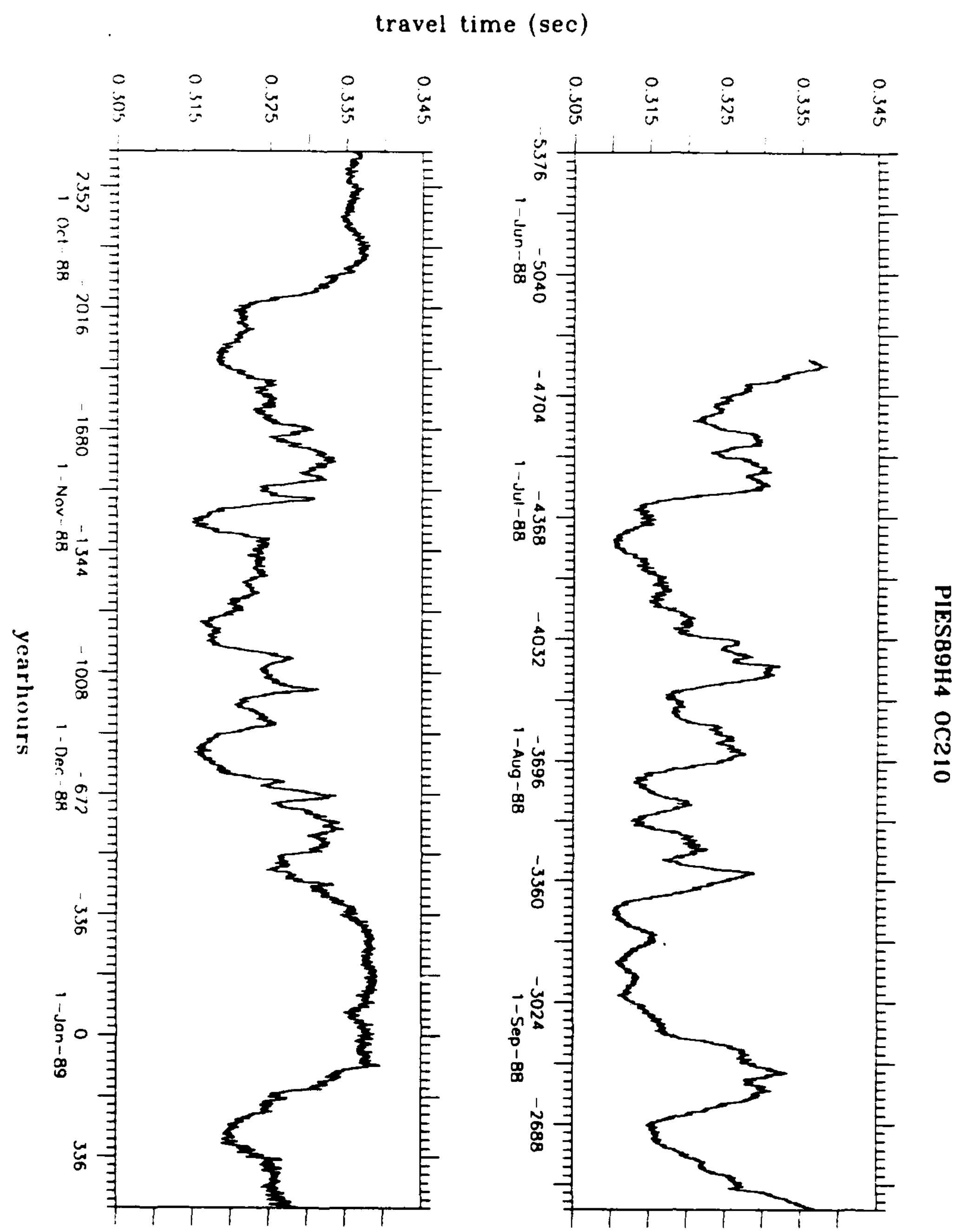
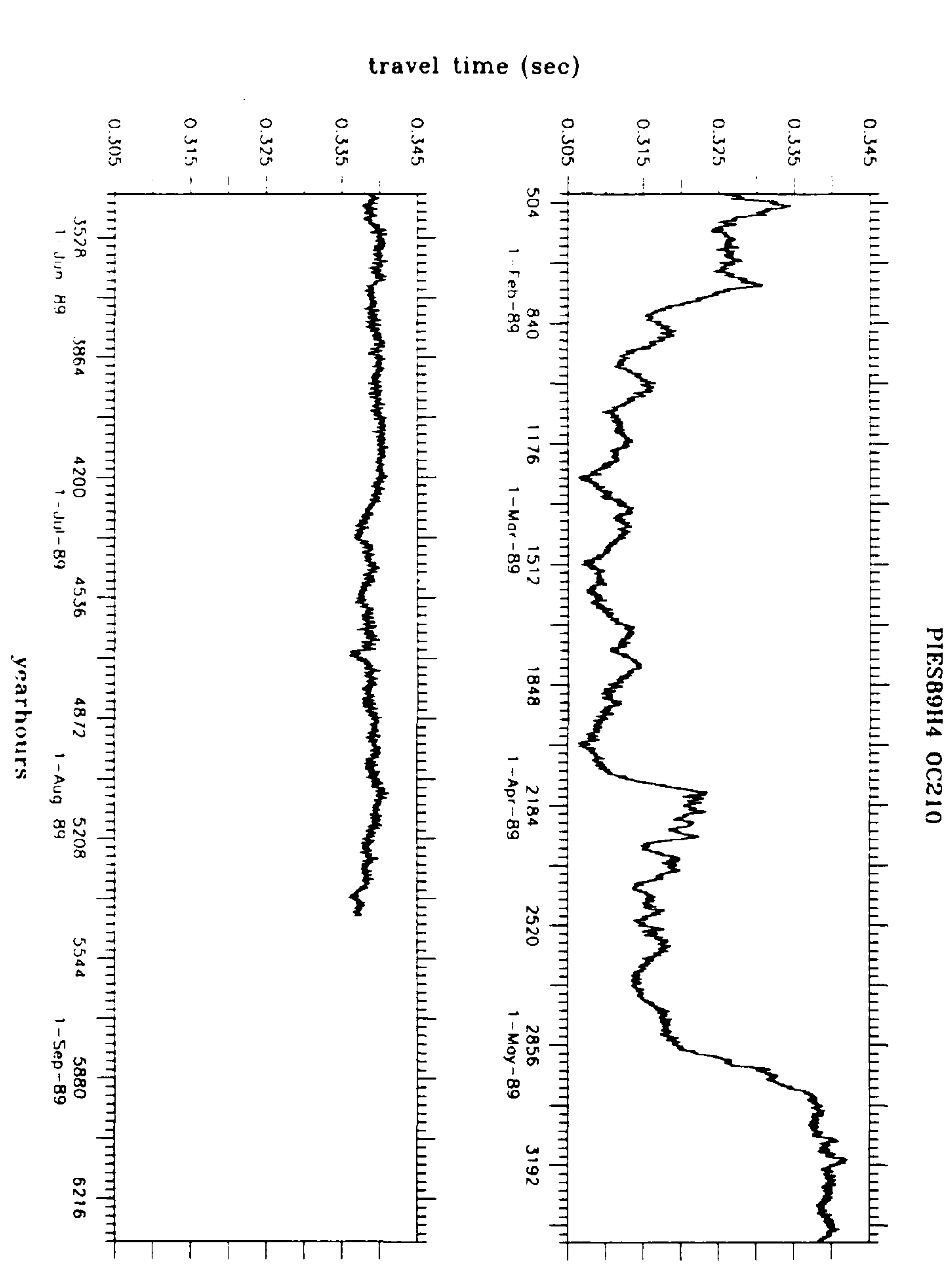


Figure 6.20: Half-Hourly Travel Times. PIES89H4_210


PIES89H4 OC210
travel time (sec)
0.305
0.315
0.325
0.335
0.345
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3864
4200
1-Jul-89
4536
4872
1-Aug 89
5208
5544
5880
1-Sep-89
6216
yearhours

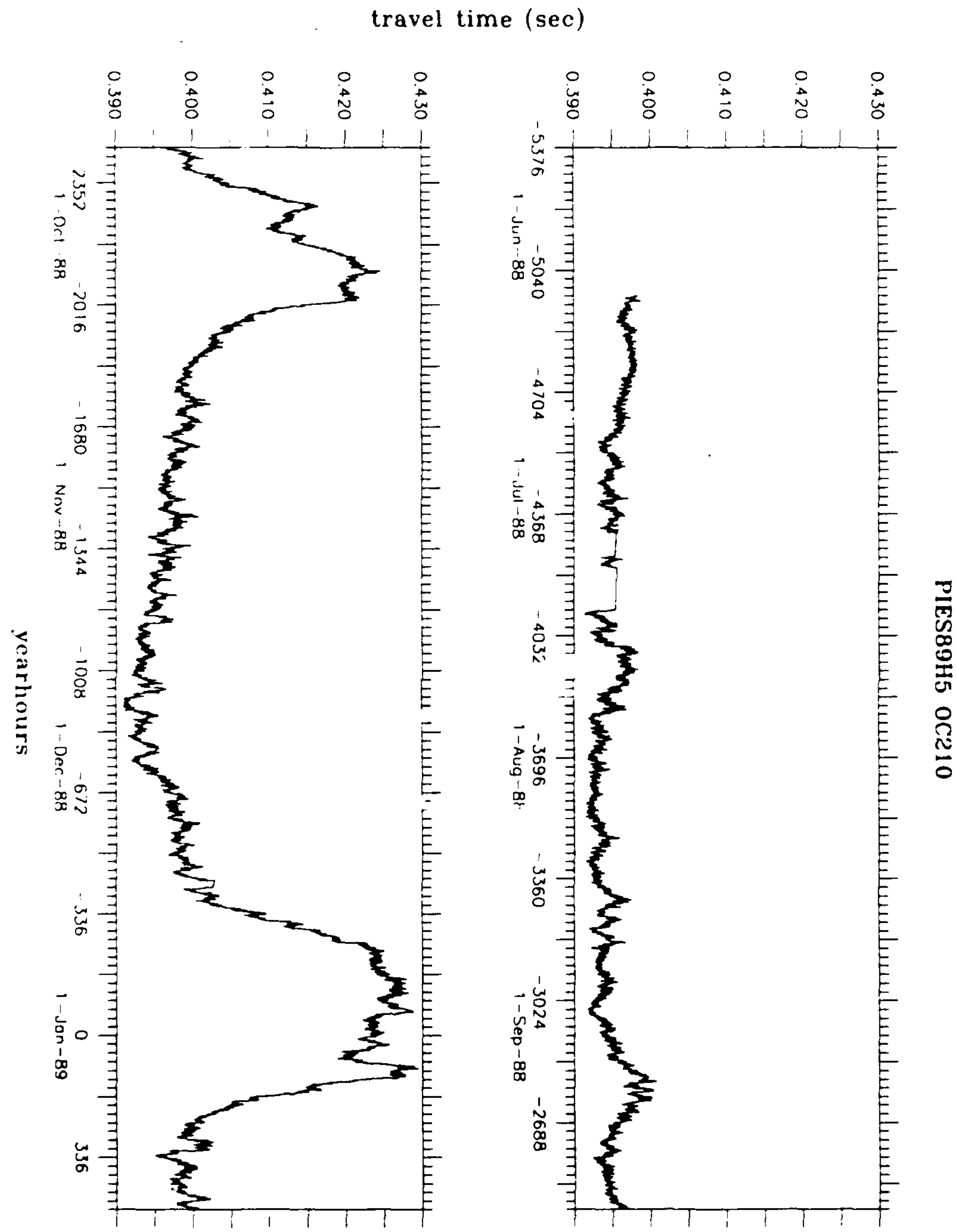
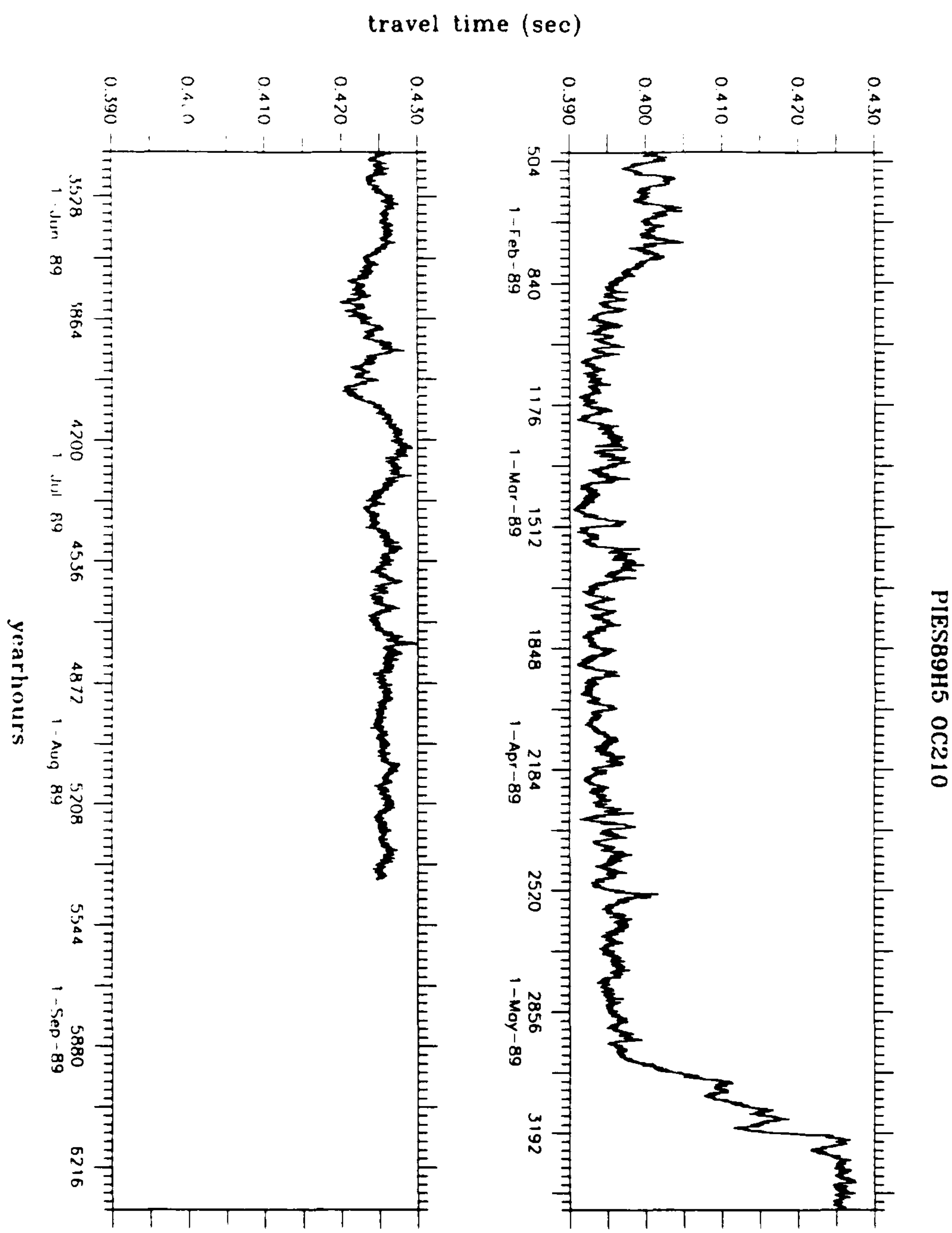


Figure 6.21: Half-Hourly Travel Times. PIES89H5_210



PIES89H5 OC210
travel time (sec)
0.390
0.400
0.410
0.420
0.430
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4877
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

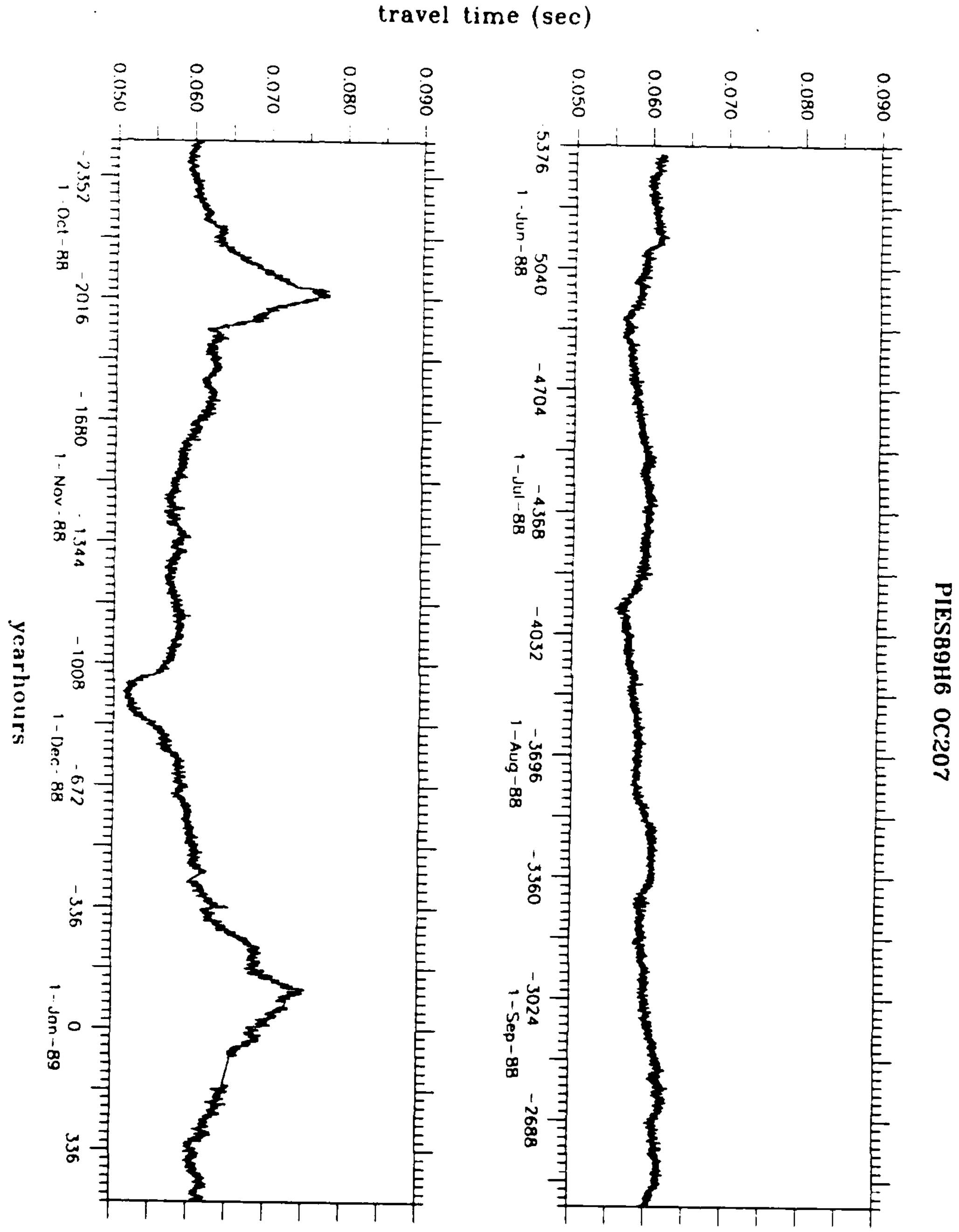
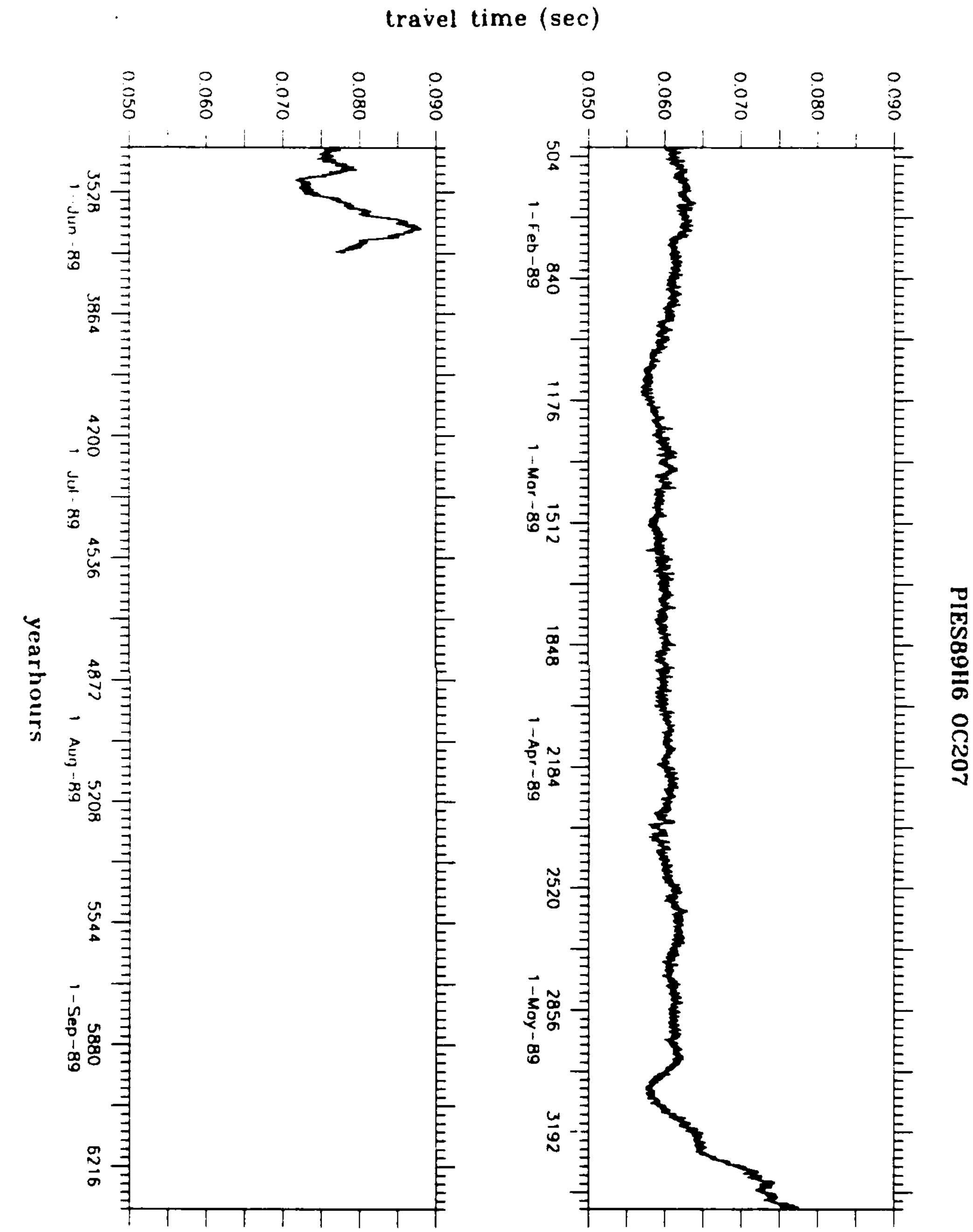


Figure 6.22: Half-Hourly Travel Times. PIES89H6_207


PIES89I6 OC207
travel time (sec)
0.050
0.060
0.070
0.080
0.090
504
1-Feb-89
840
1176
1-Mar-89
1512
1848
1-Apr-89
2184
2520
1-May-89
2856
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4877
1-Aug-89
5208
5544
1-Sep-89
5880
6216
yearhours

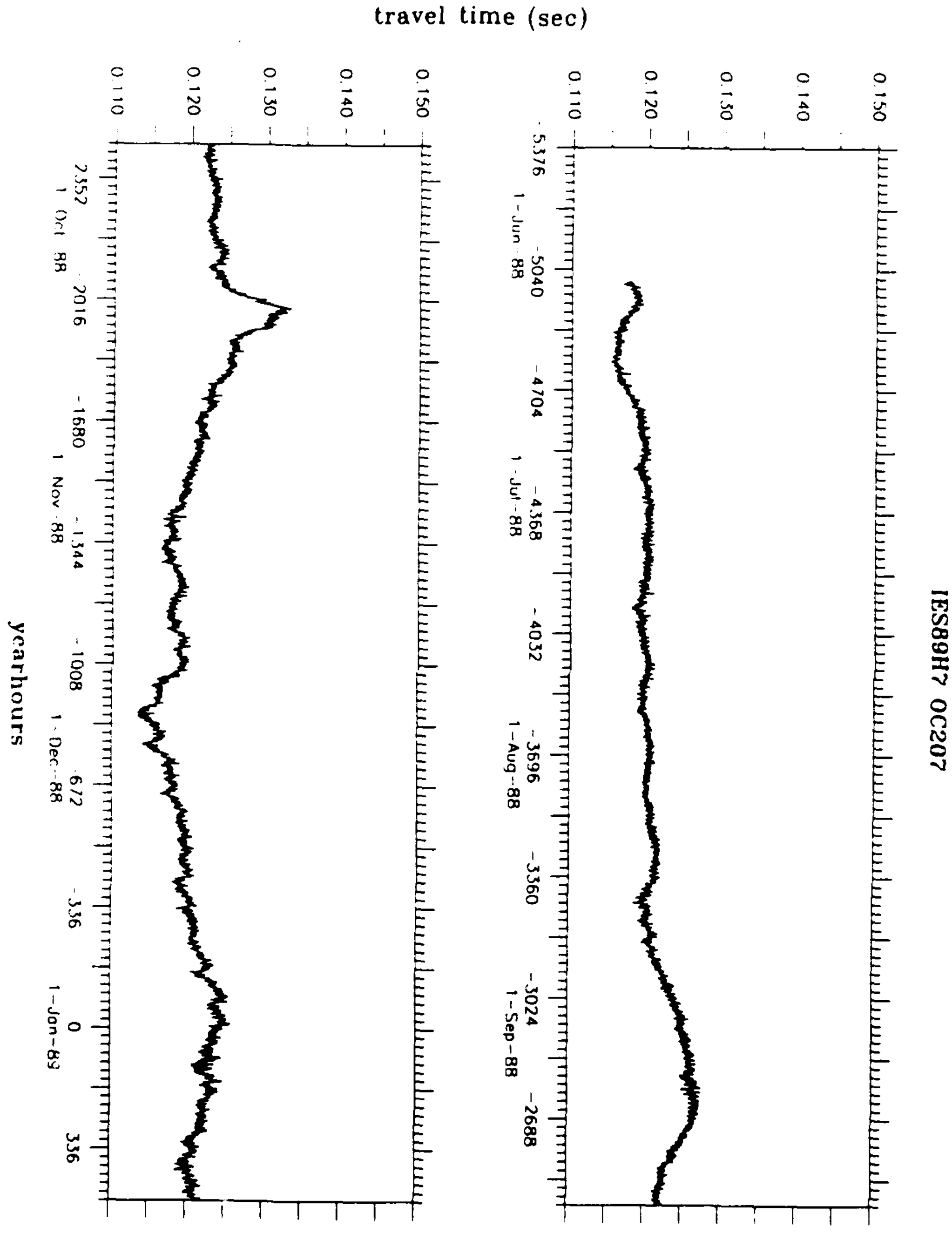
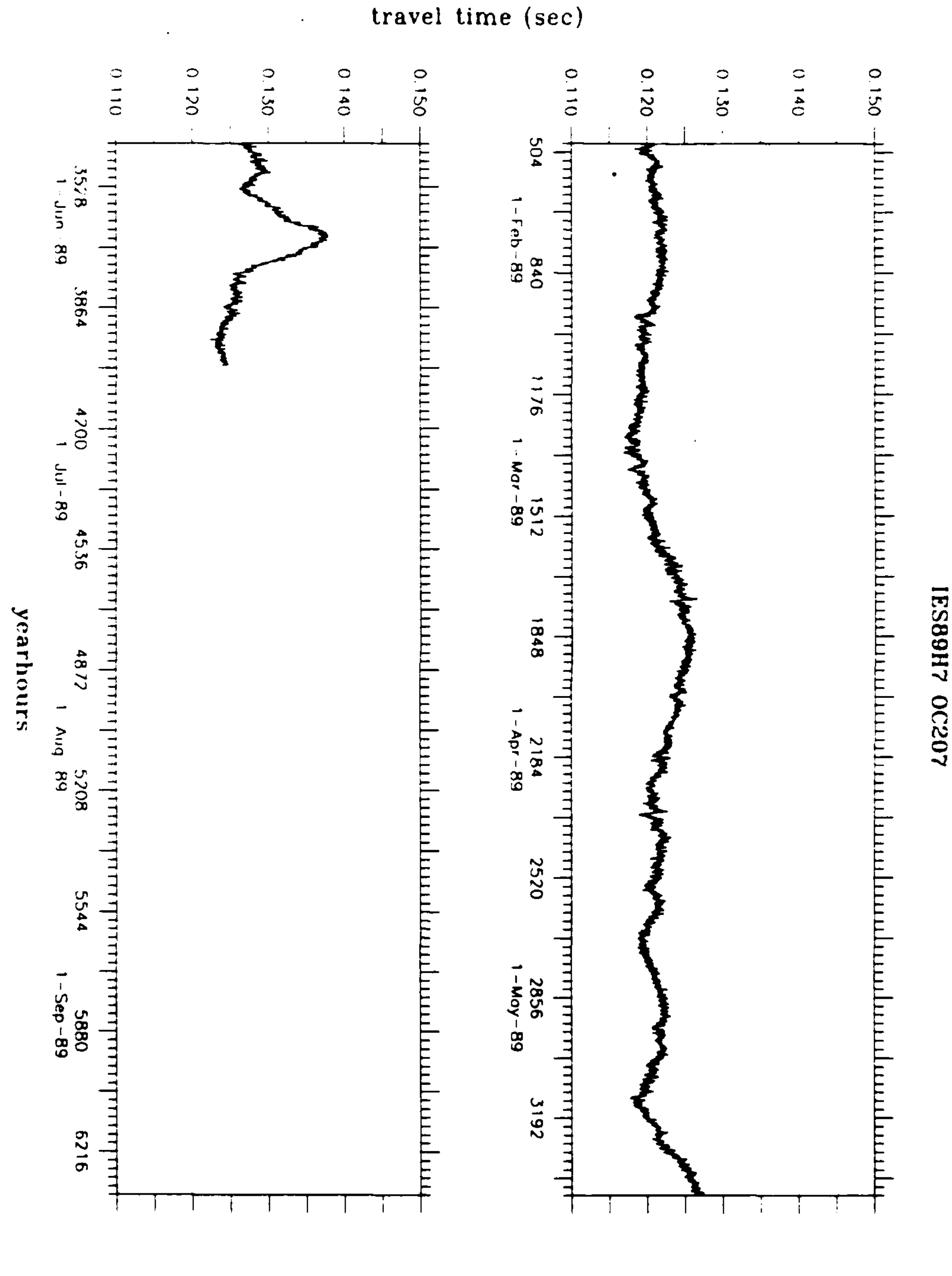


Figure 6.23: Half-Hourly Travel Times. IES89H7_207


IES89H7 OC207
travel time (sec)
0.110
0.120
0.130
0.140
0.150
504
1-Feb-89
840
1176
1-Mar-89
1512
1848
1-Apr-89
2184
2520
1-May-89
2856
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
1-Sep-89
5880
6216
yearhours

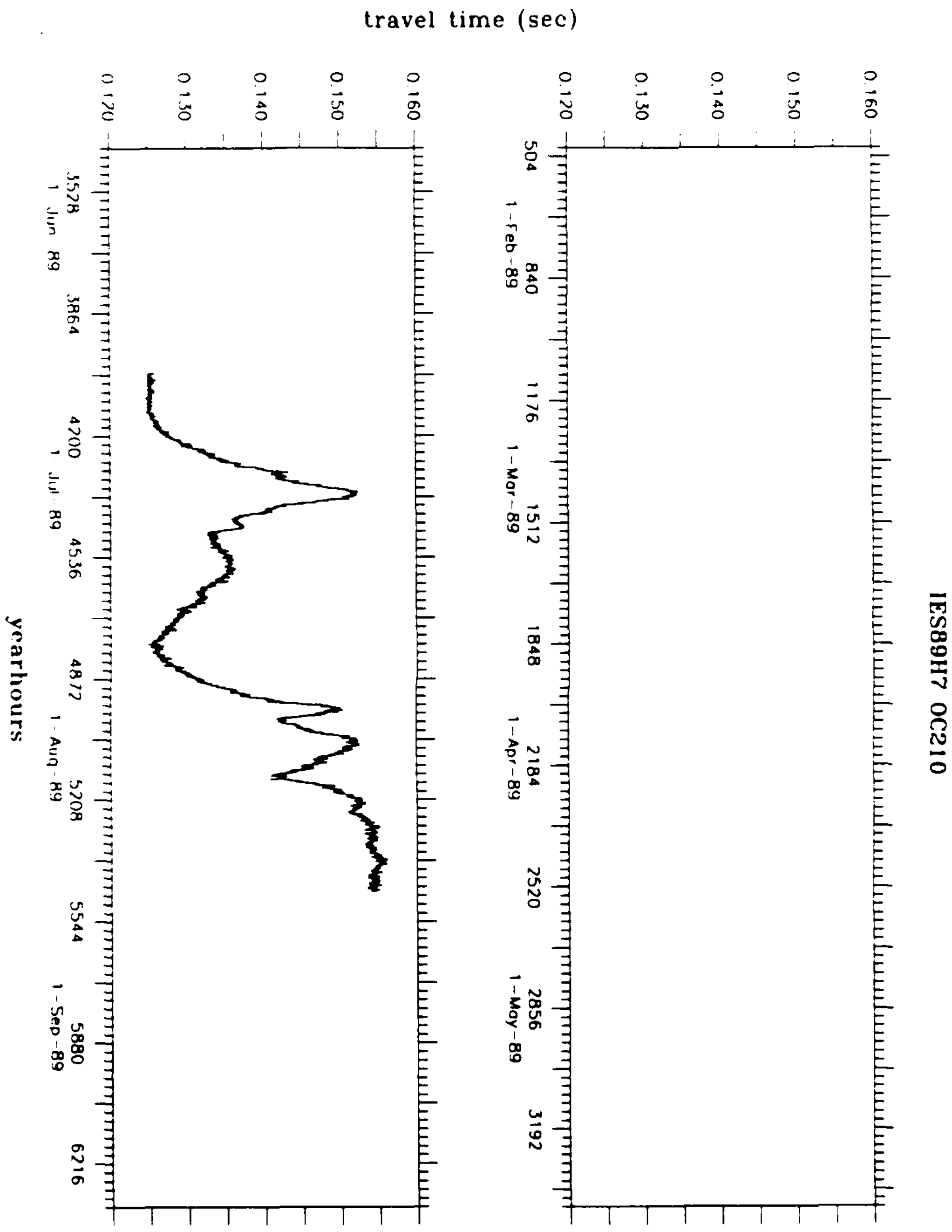


Figure 6.24: Half-Hourly Travel Times. 6.24: IES89H7_210

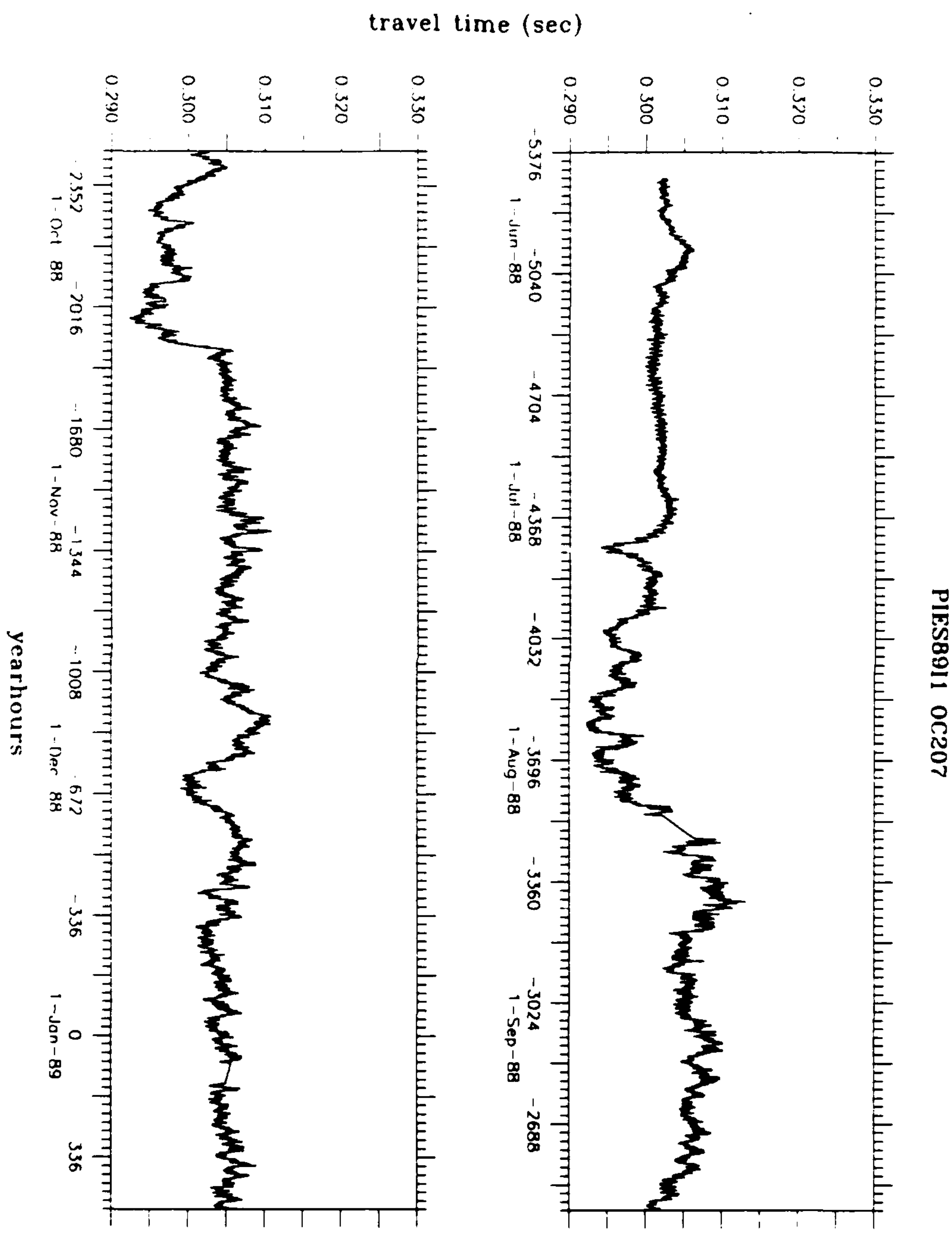
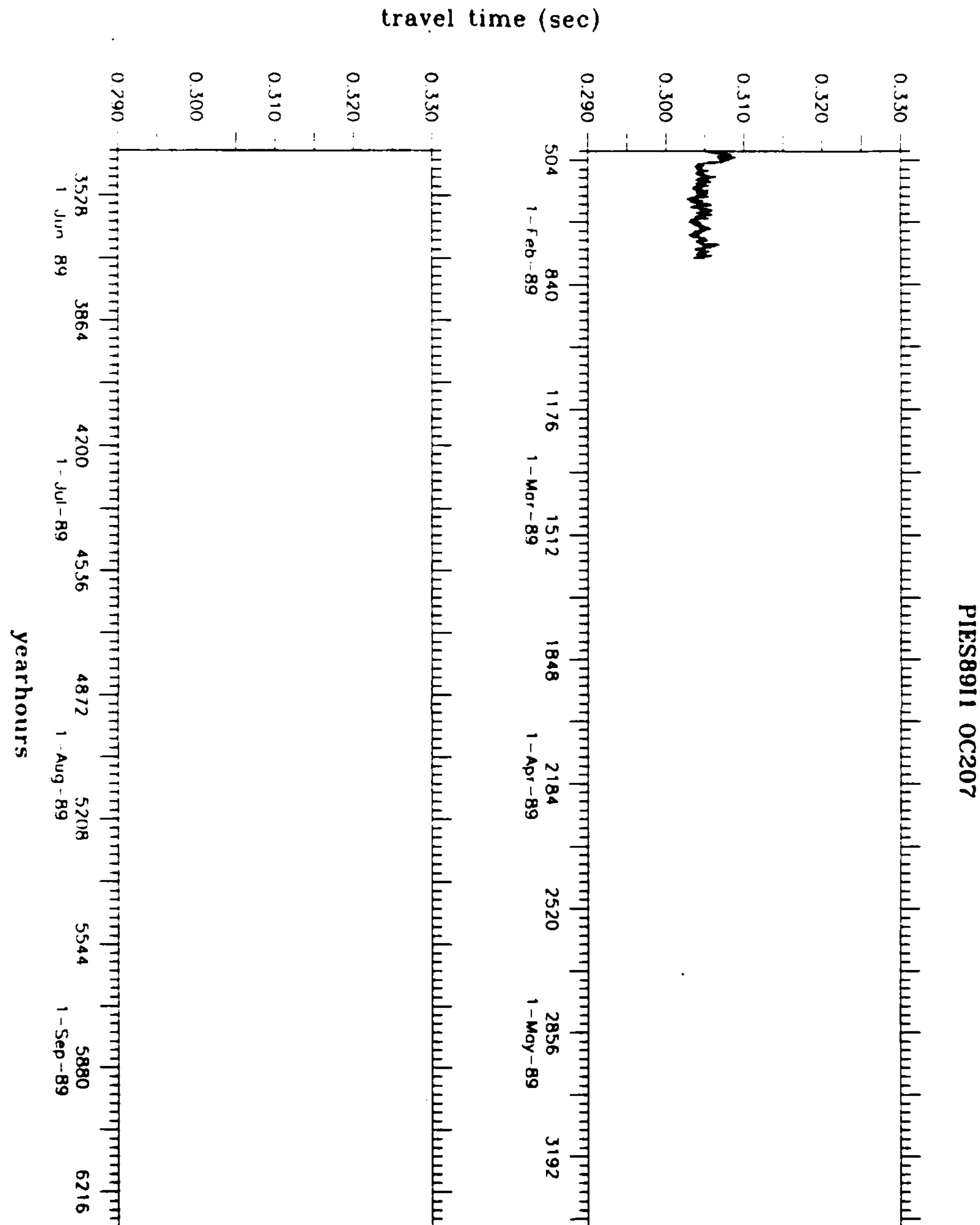


Figure 6.25: Half-Hourly Travel Times. PIES89I1_207


PIES89I1 OC207
travel time (sec)
0.290
0.300
0.310
0.320
0.330
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1 Jun 89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

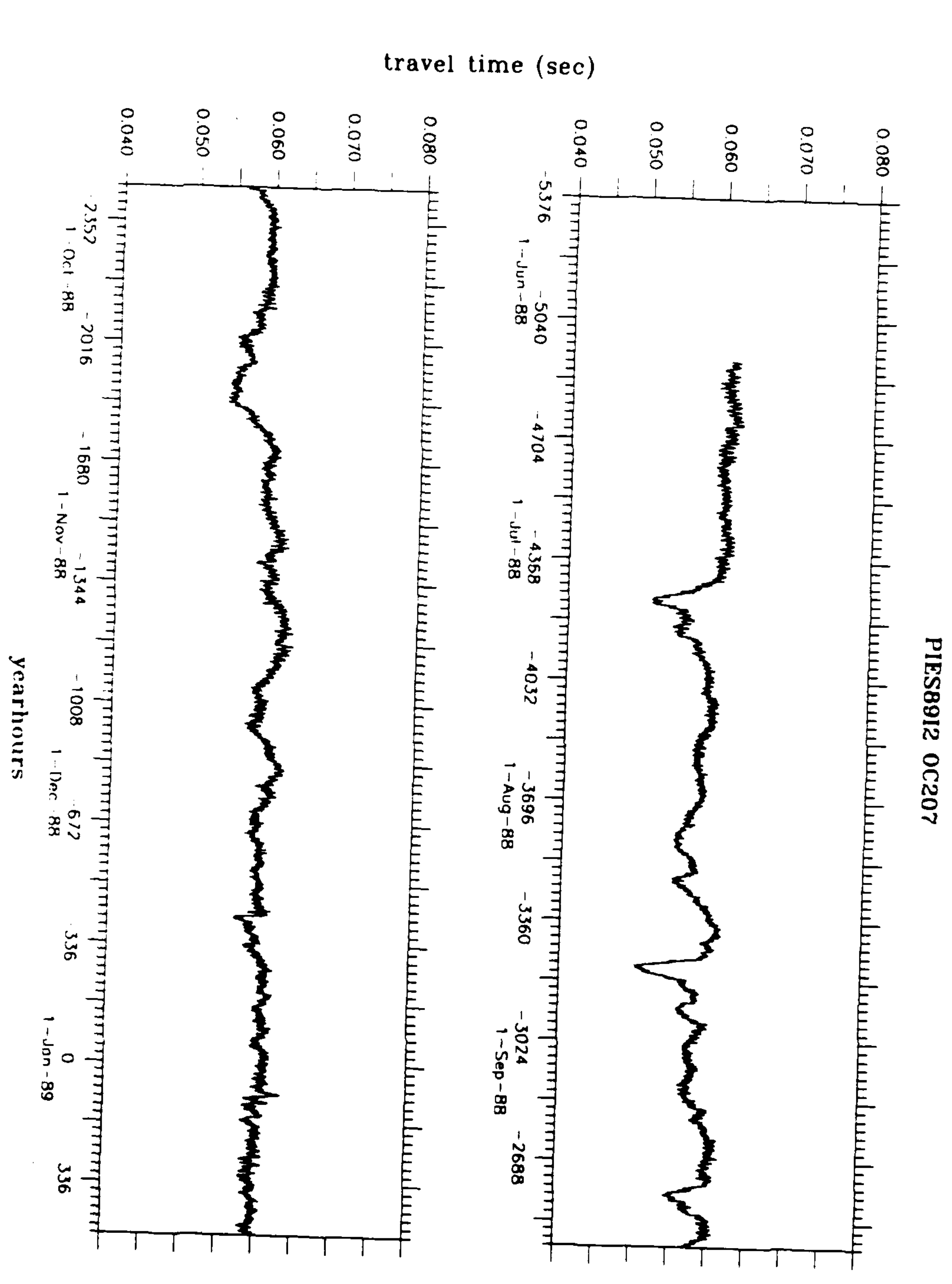


Figure 6.26: Half-Hourly Travel Times. PIES89I2_207

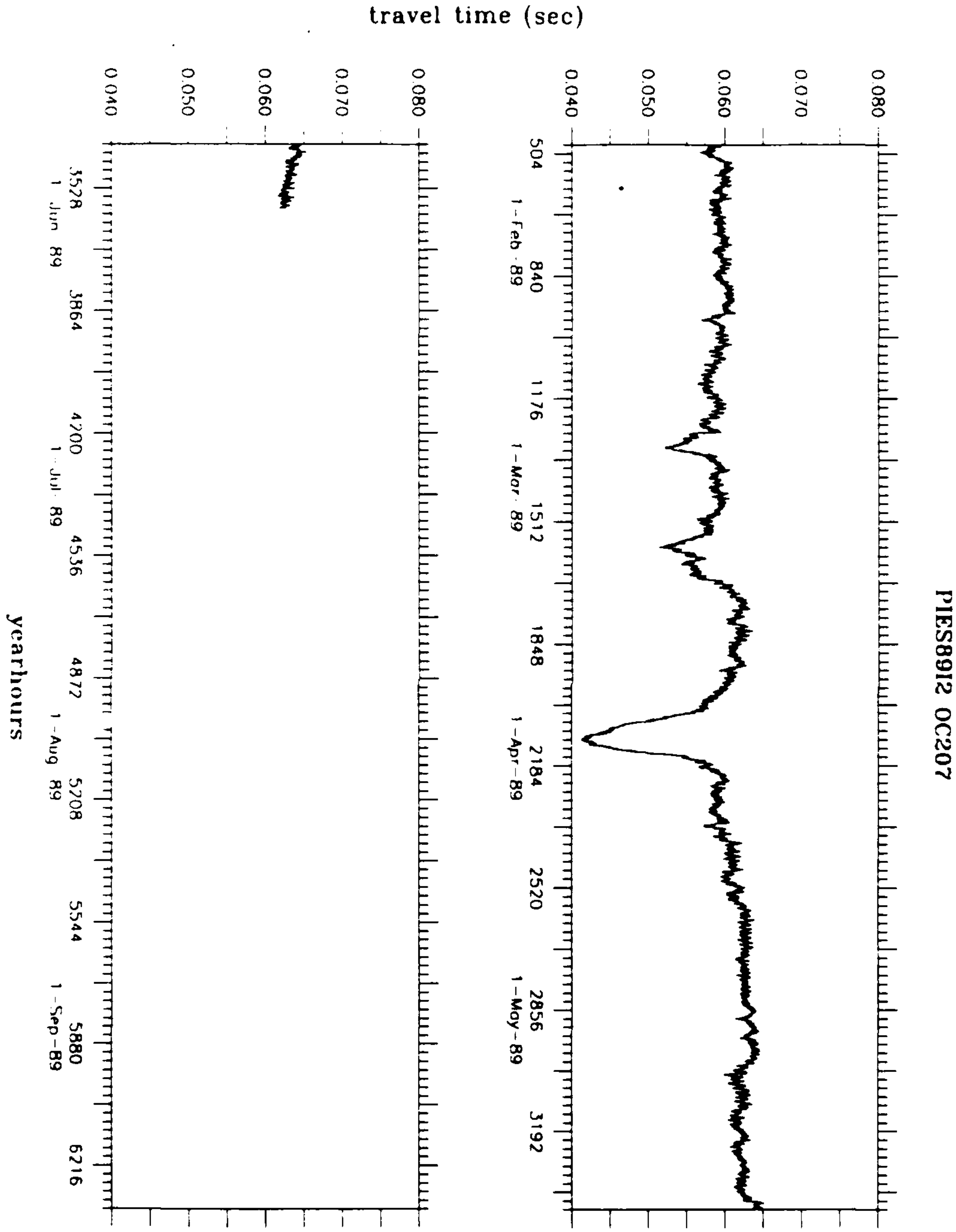


Figure 6.26: Half-Hourly Travel Times. PIES89I2_207

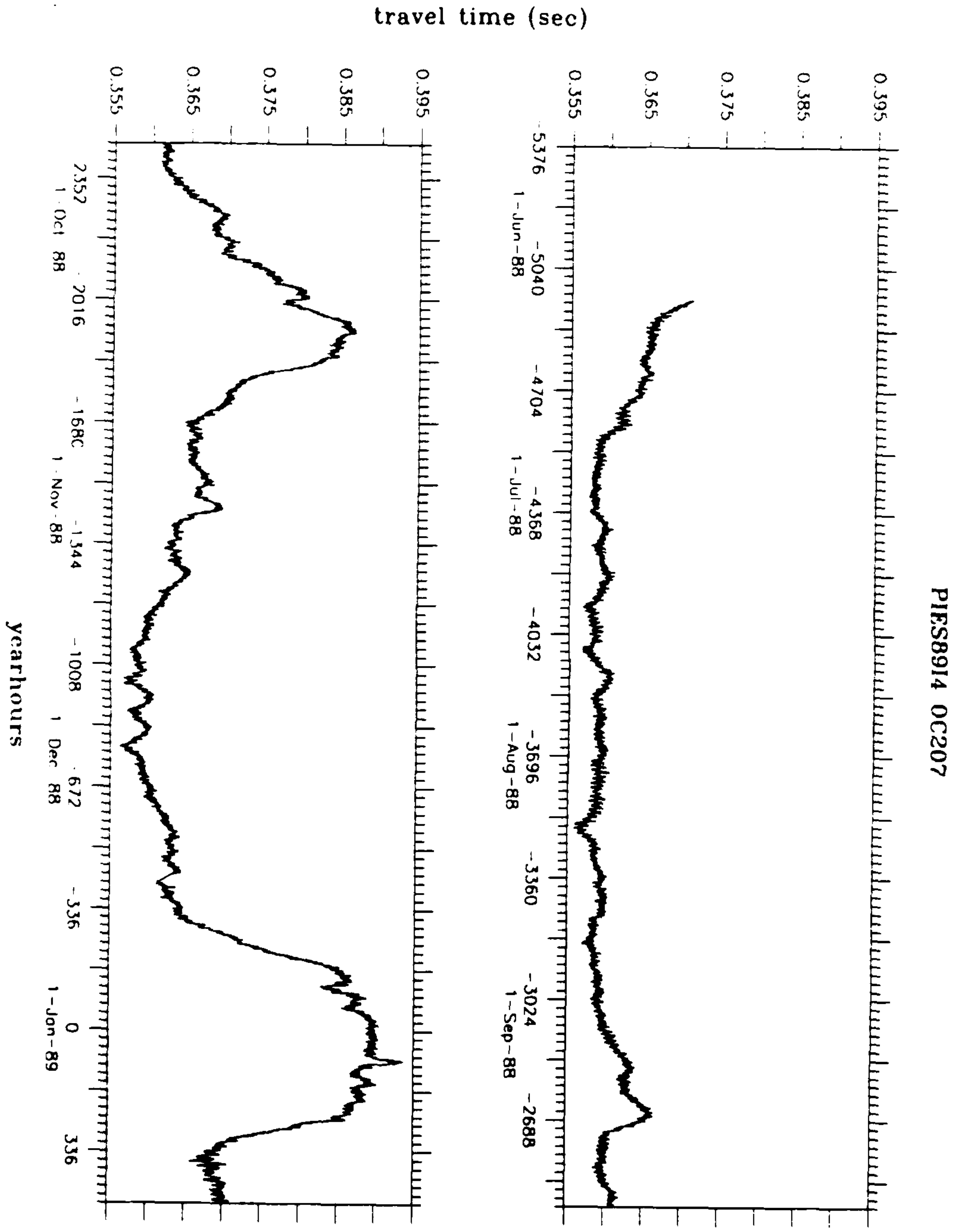
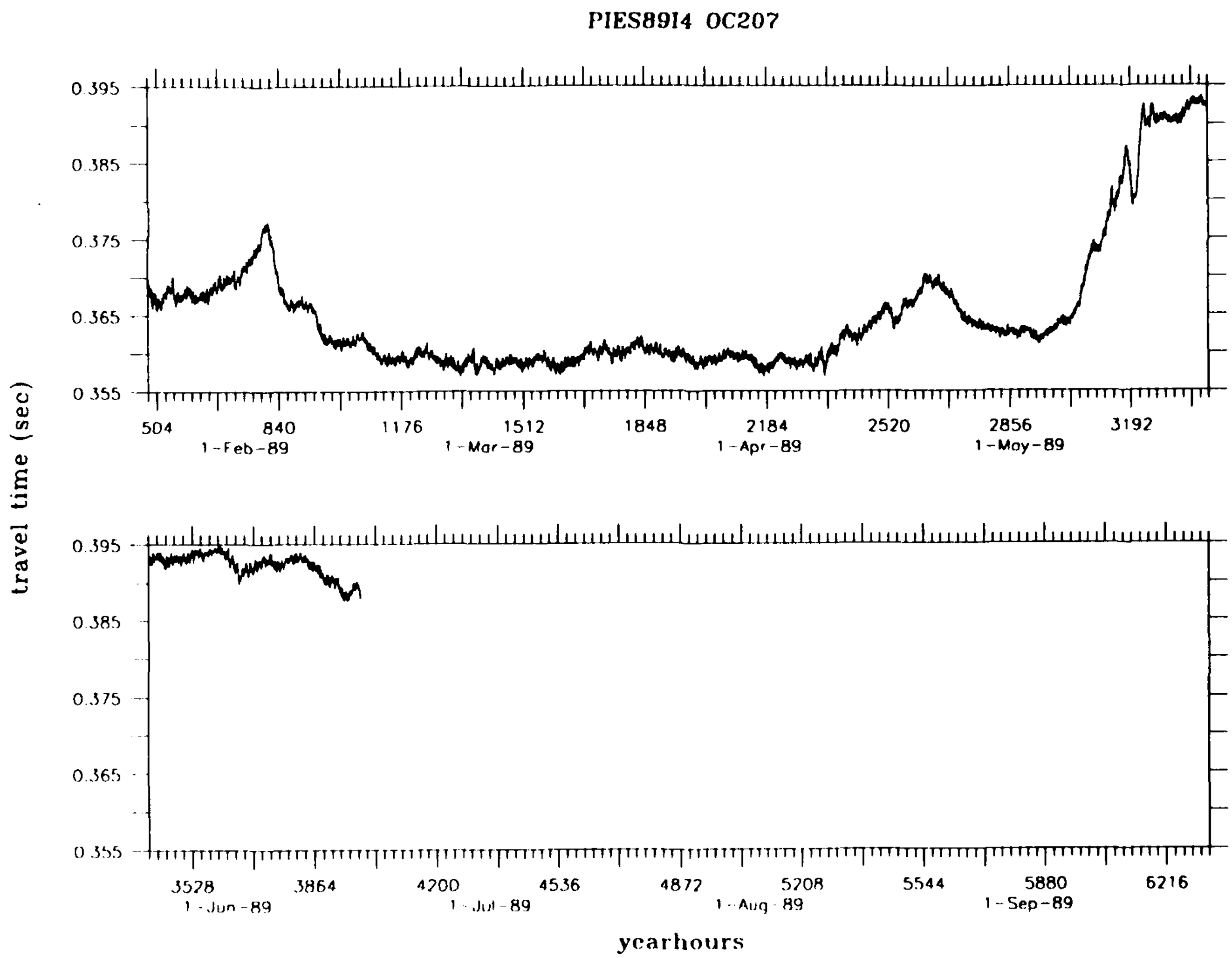


Figure 6.27: Half-Hourly Travel Times. PIES89I4_207


PIES8914 OC207
travel time (sec)
0.395
0.385
0.375
0.365
0.355
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

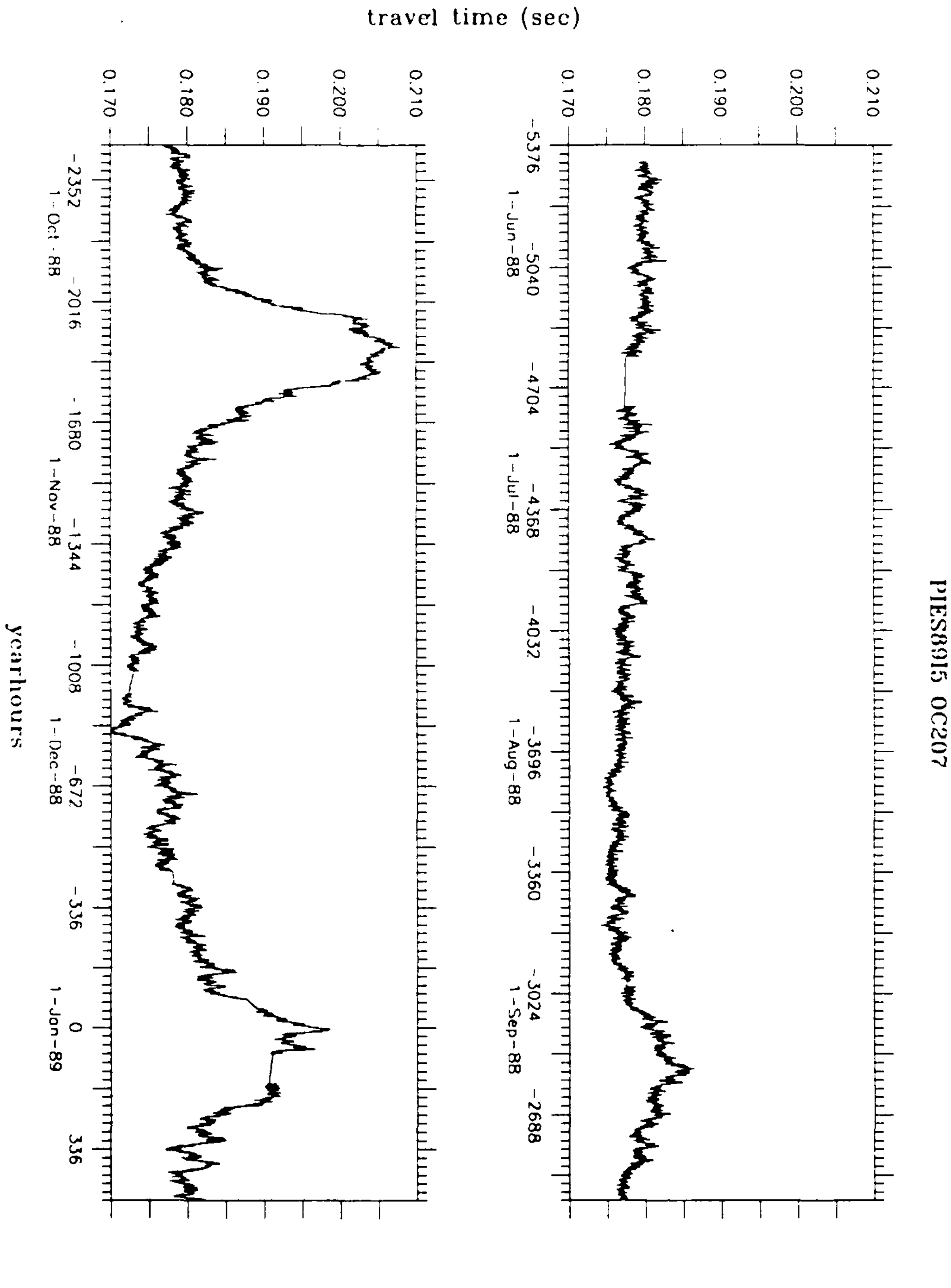
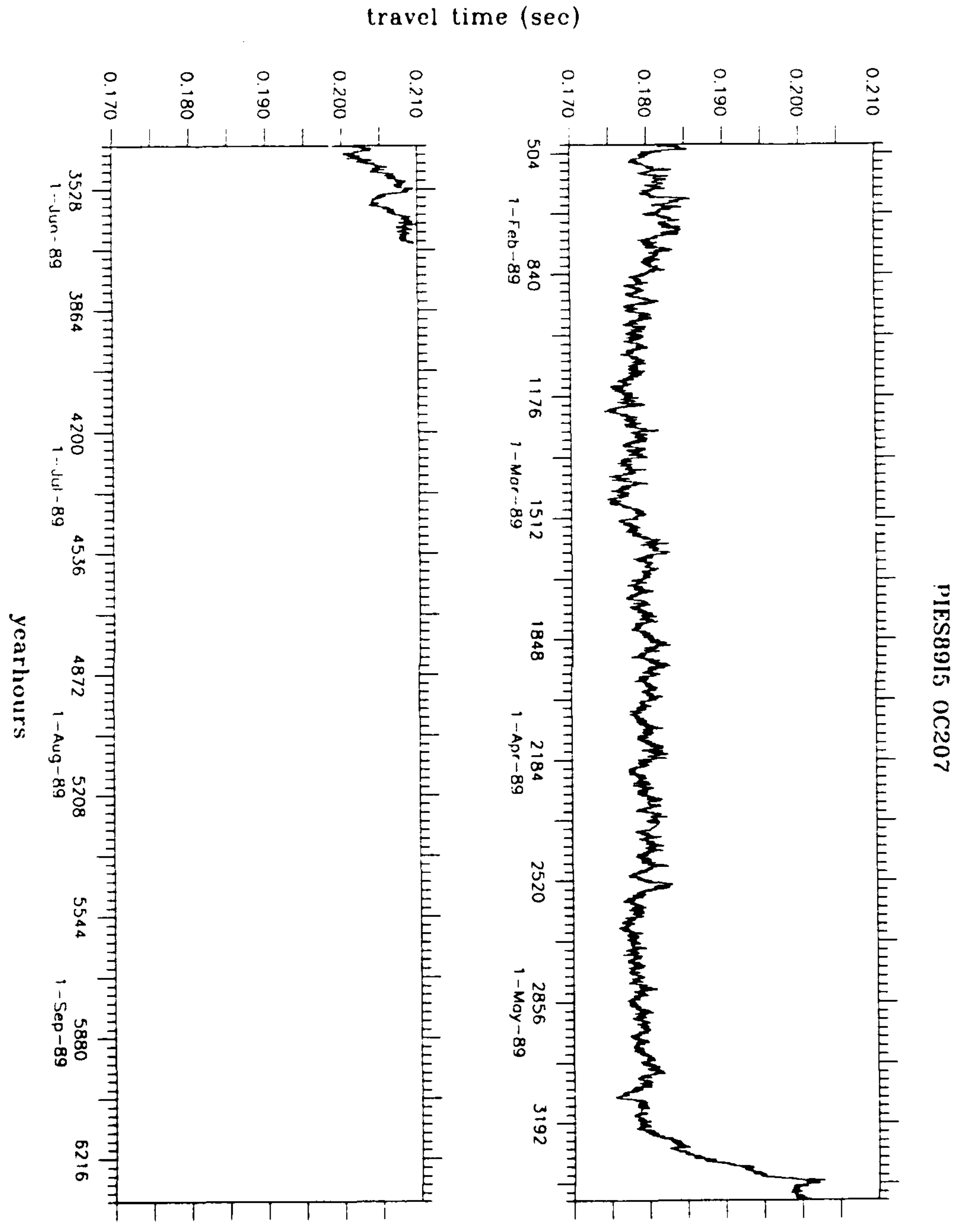


Figure 6.28: Half-Hourly Travel Times. PIES89I5_207


PIES8915 OC207
travel time (sec)
0.170
0.180
0.190
0.200
0.210
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

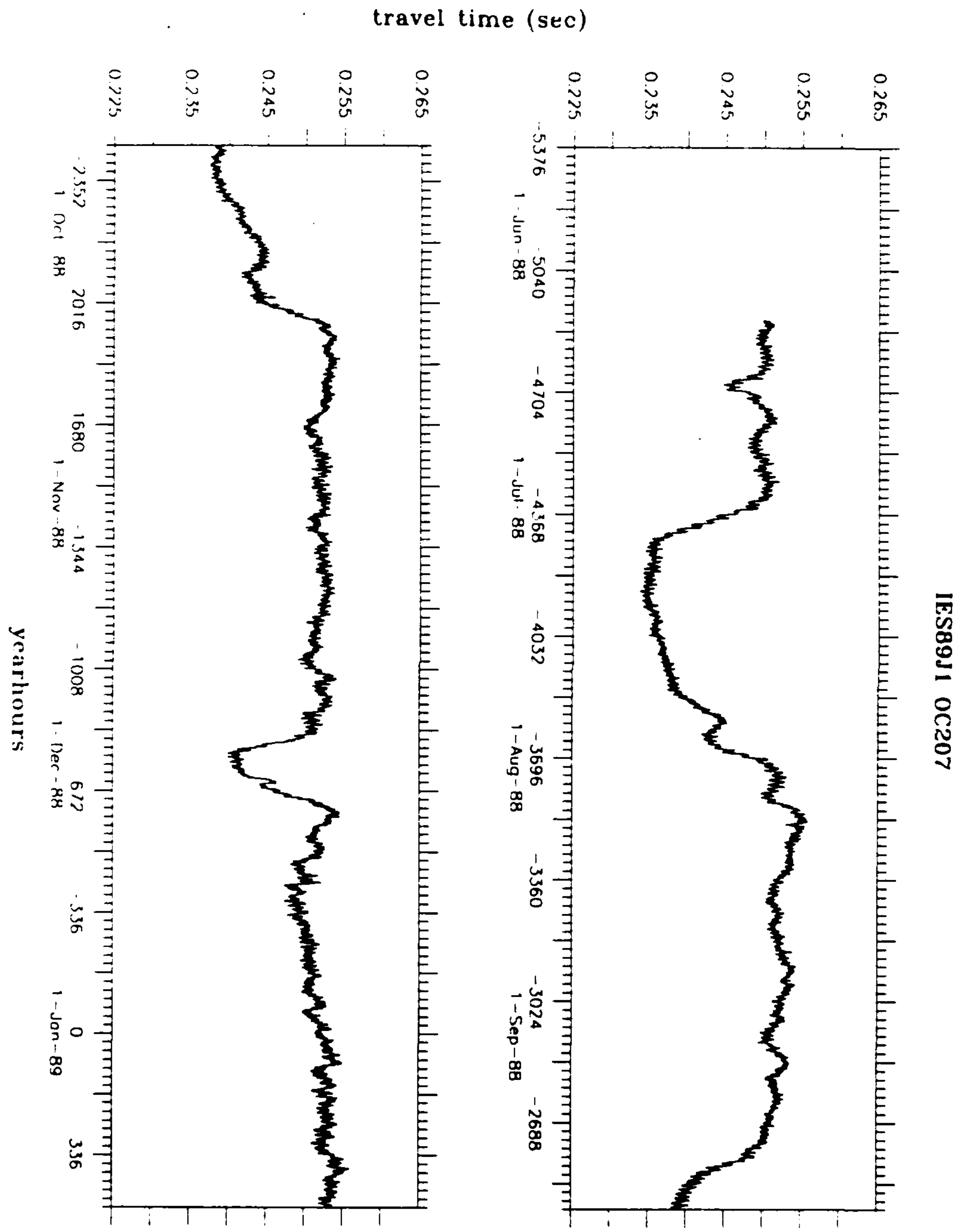
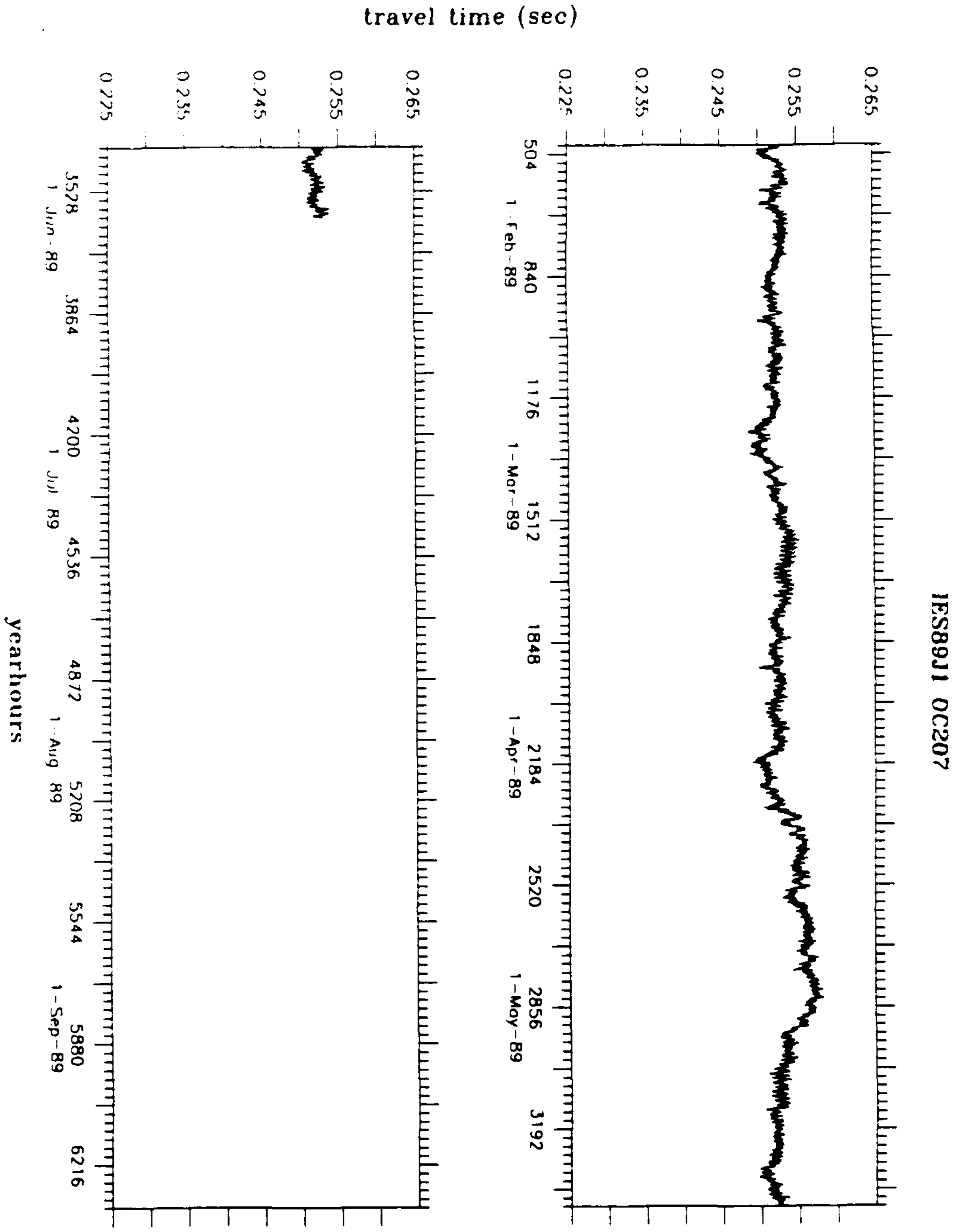


Figure 6.29: Half-Hourly Travel Times. IES89J1_207


IES89J1 OC207
travel time (sec)
0.265
0.255
0.245
0.235
504
1-Feb-89
840
1176
1-Mar-89
1512
1848
1-Apr-89
2184
2520
1-May-89
2856
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
1-Sep-89
5880
6216
yearhours

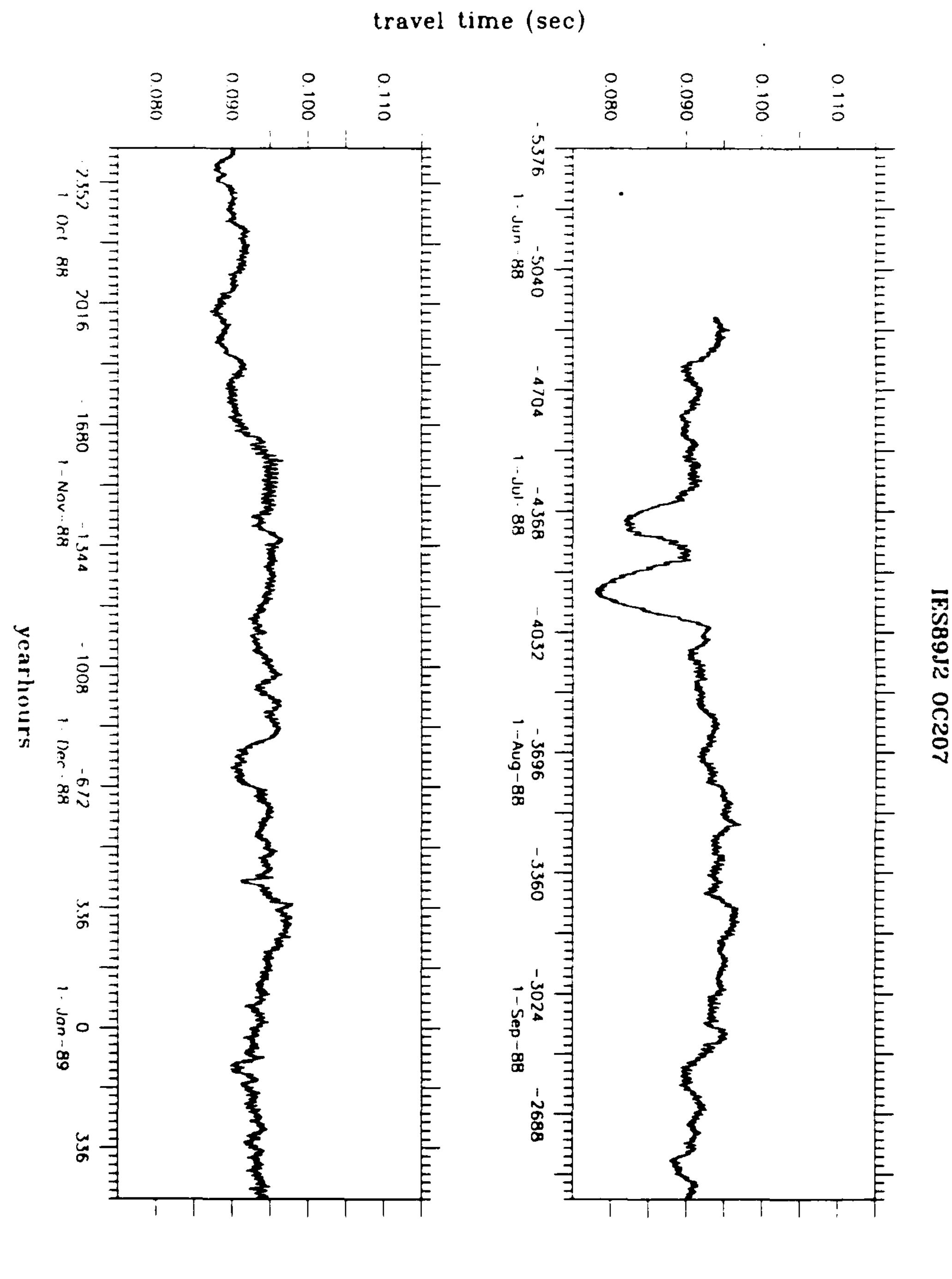
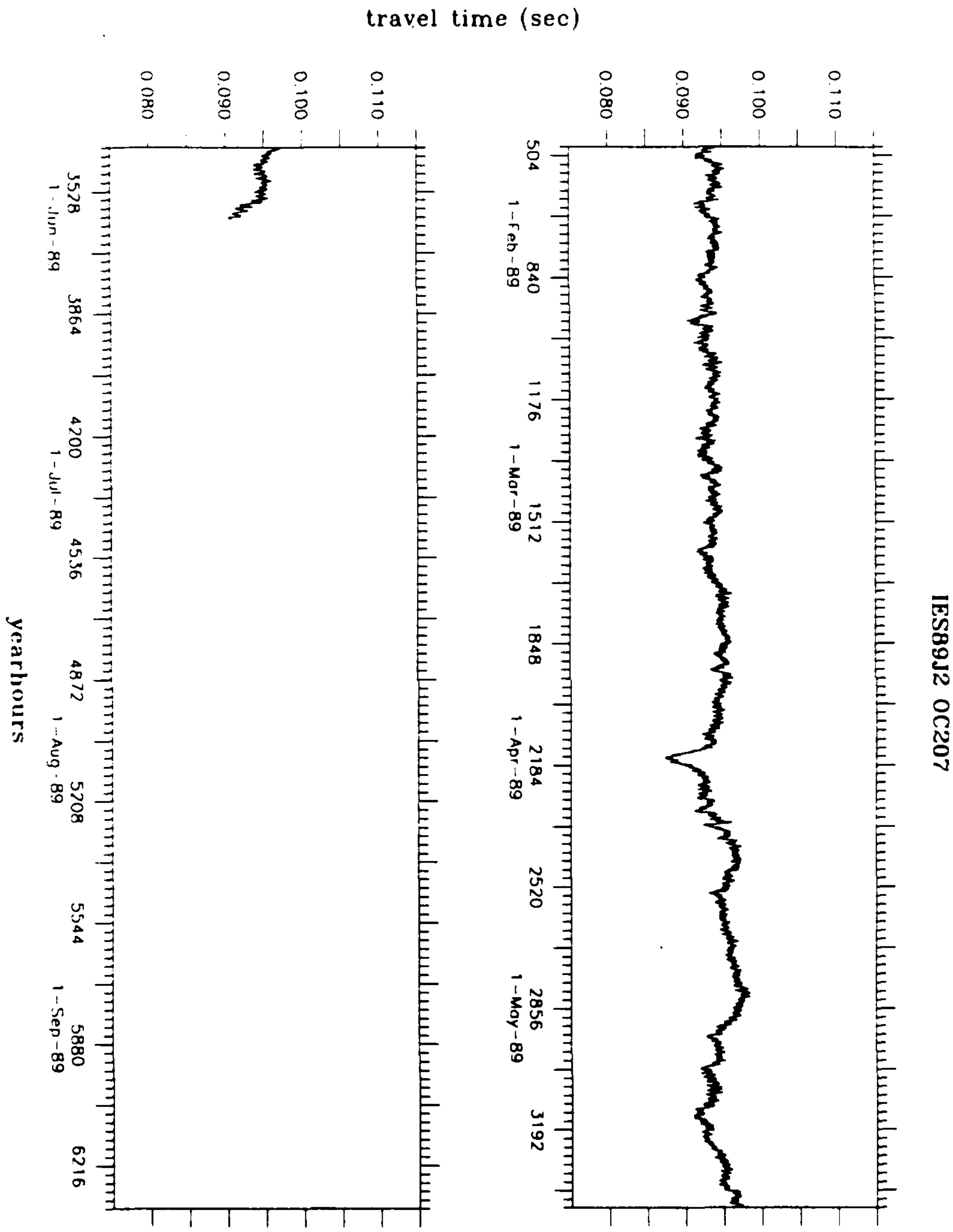


Figure 6.30: Half-Hourly Travel Times. IES89J2_207


IES89J2 OC207
travel time (sec)
0.080
0.090
0.100
0.110
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

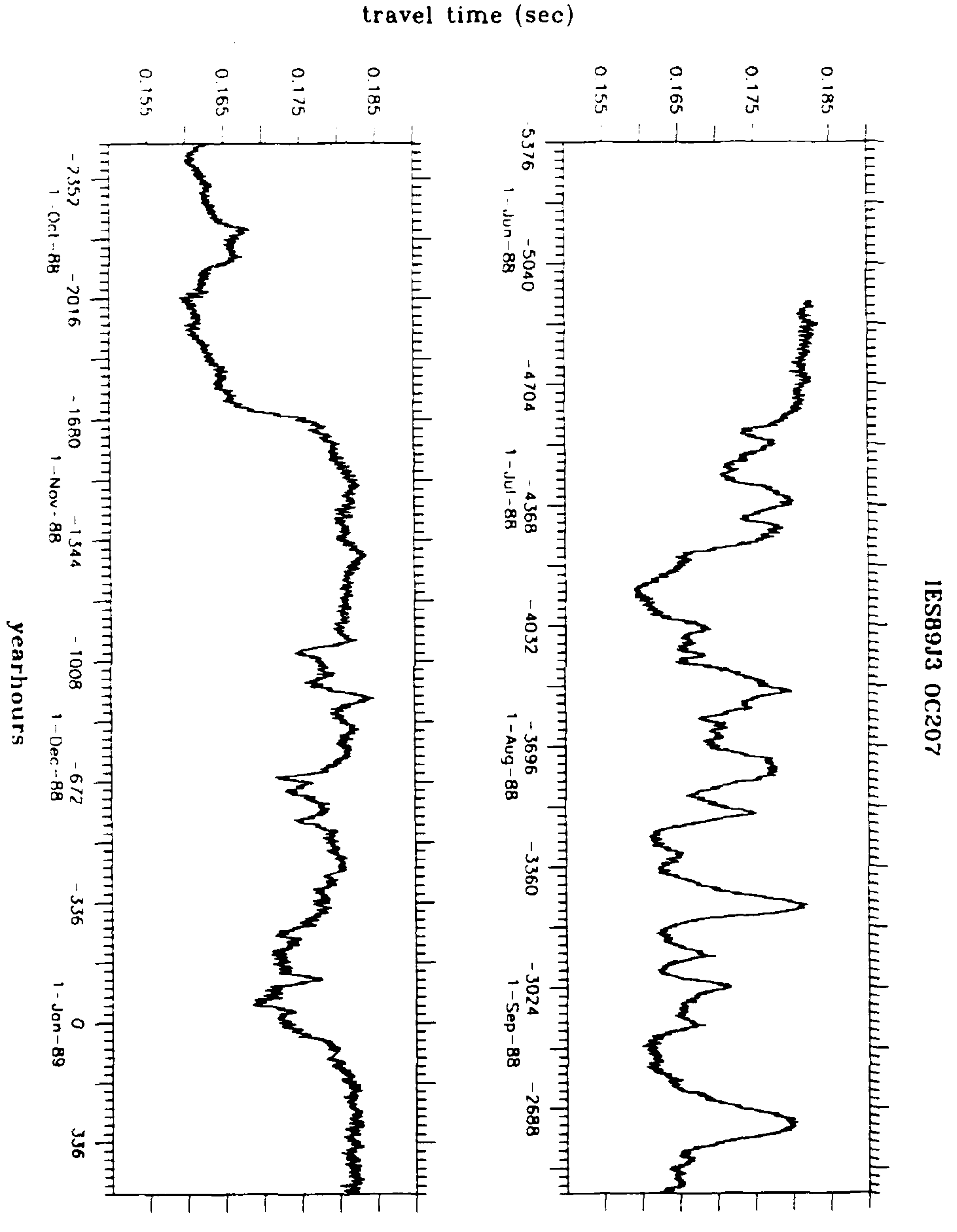
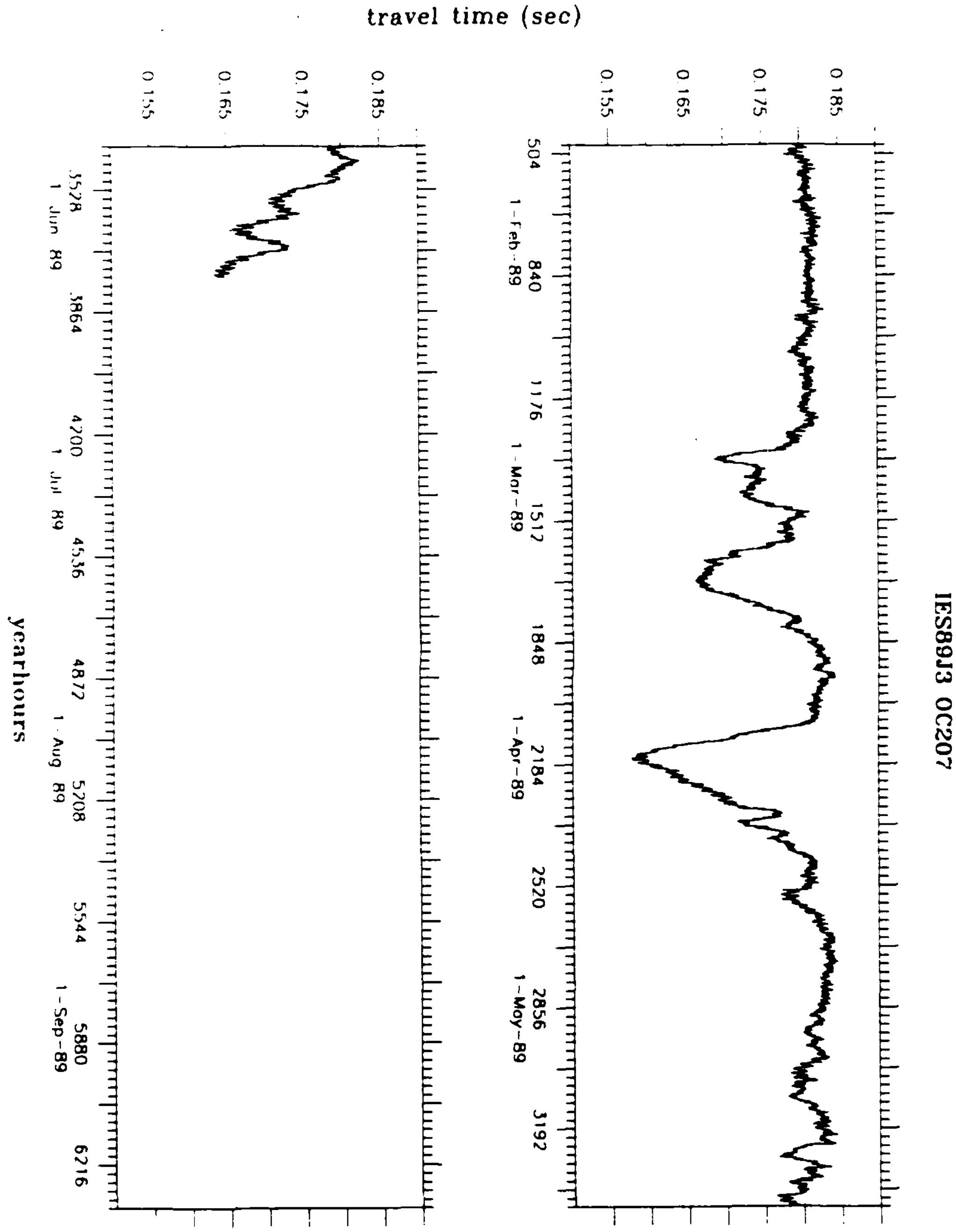


Figure 6.31: Half-Hourly Travel Times. IES89J3_207



IES89J3 OC207
travel time (sec)
0.185
0.175
0.165
0.155
504
840
1-Feb-89
1176
1517
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1 Jun 89
3864
4200
1 Jul 89
4536
4877
1 Aug 89
5208
5544
5880
1-Sep-89
6216
yearhours

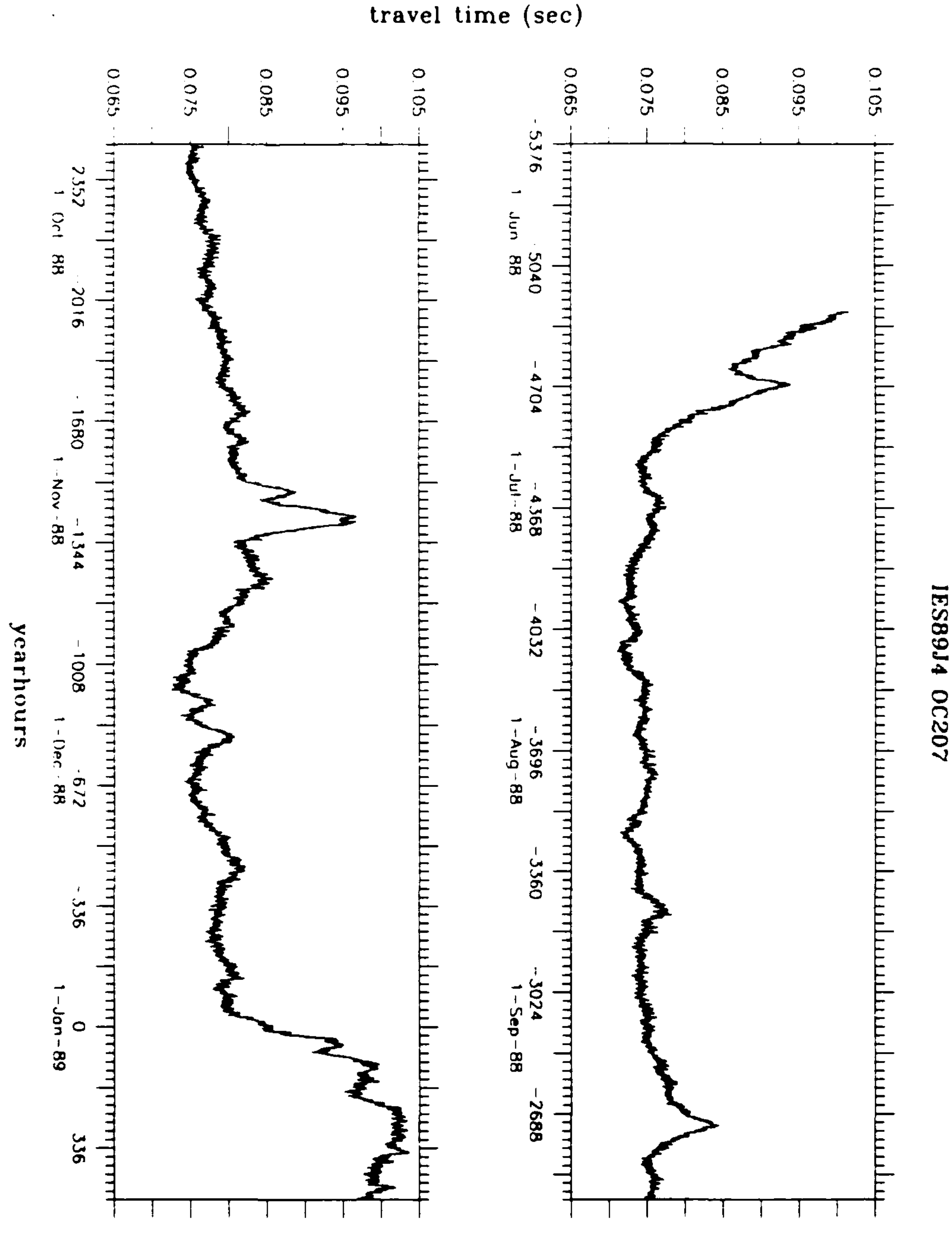
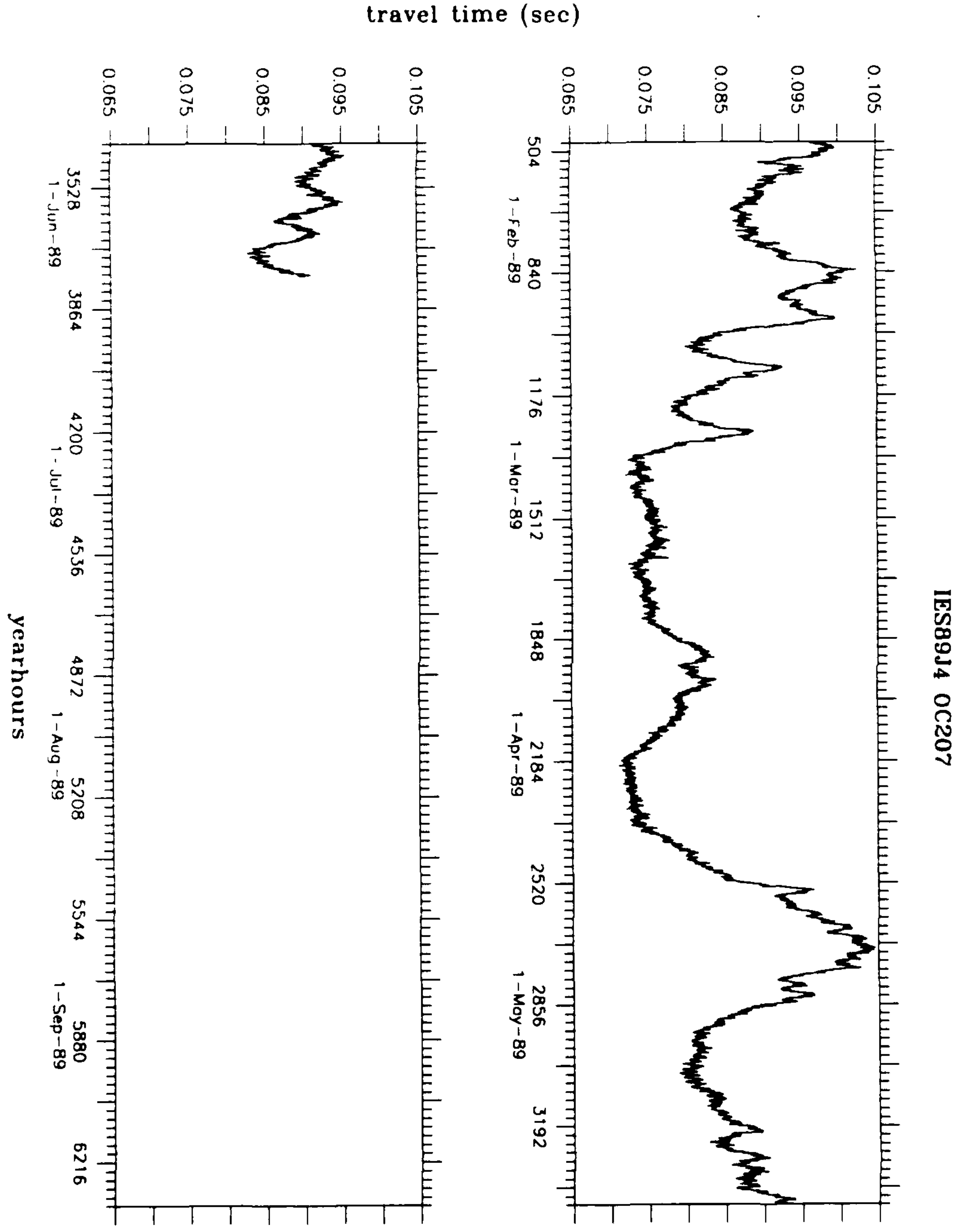


Figure 6.32: Half-Hourly Travel Times. PIES89J4_207


IES89J4 OC207
travel time (sec)
yearhours
0.065
0.075
0.085
0.095
0.105
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216

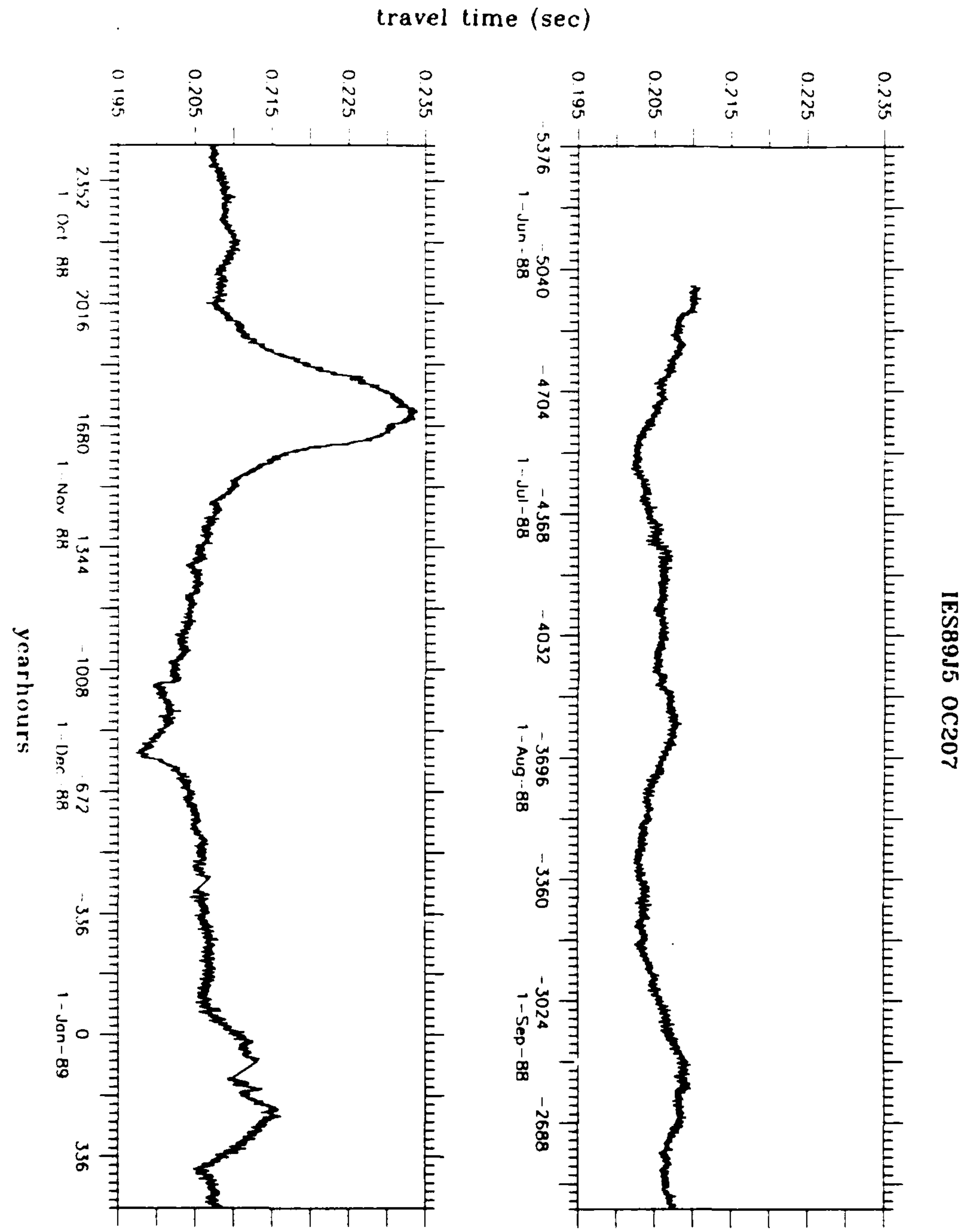
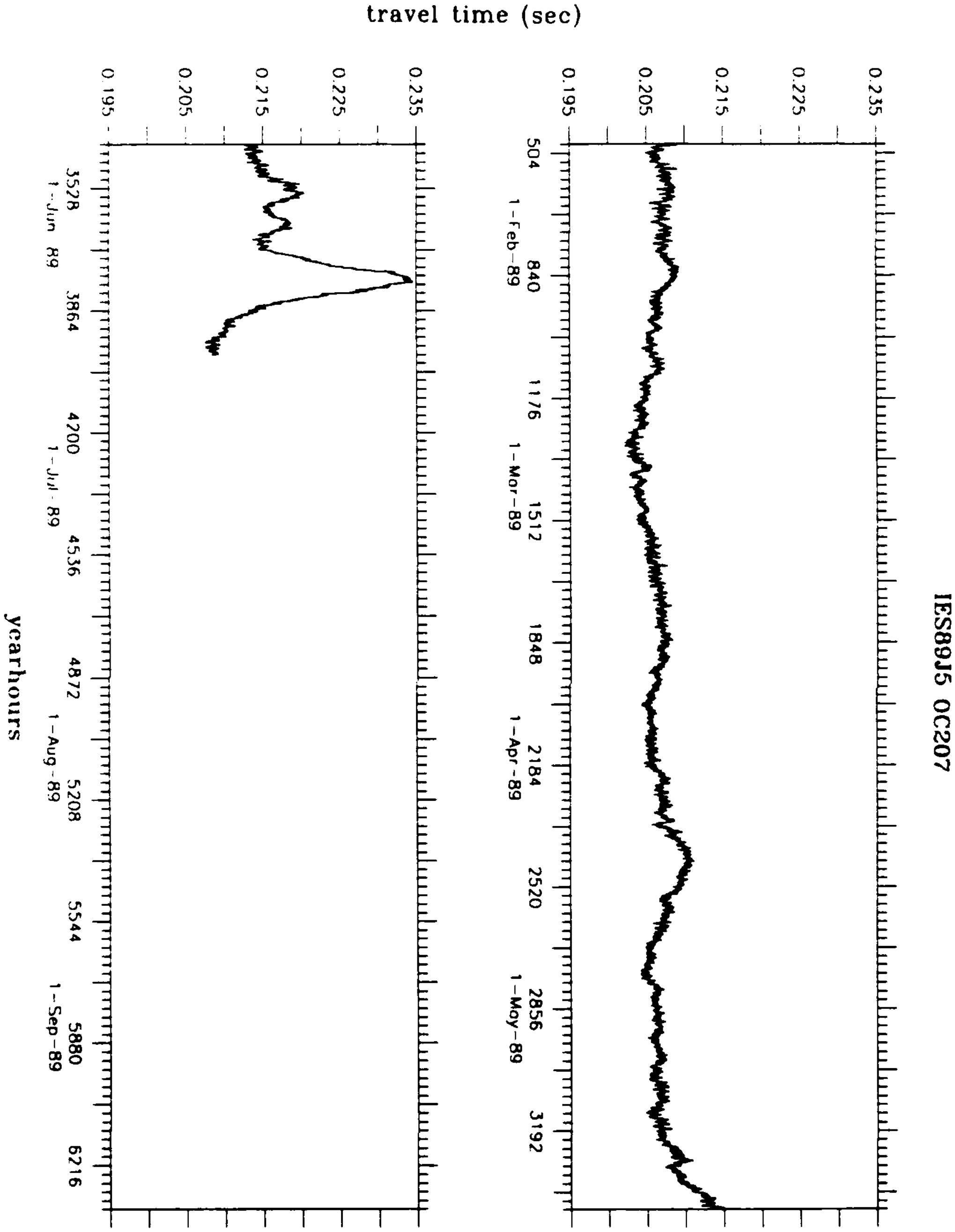


Figure 6.33: Half-Hourly Travel Times. PIES89J5_207



IES89J5 OC207
travel time (sec)
0.195
0.205
0.215
0.225
0.235
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

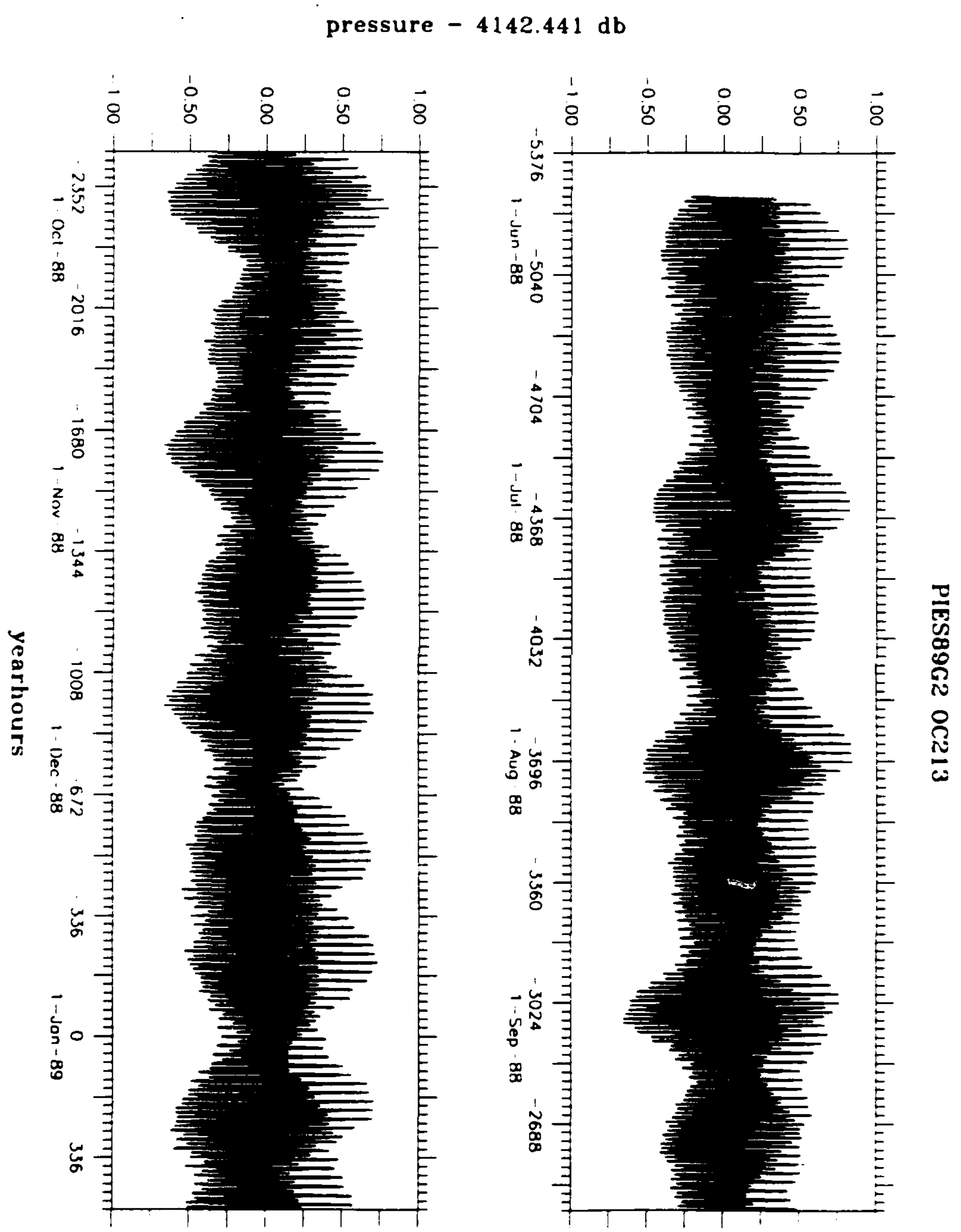
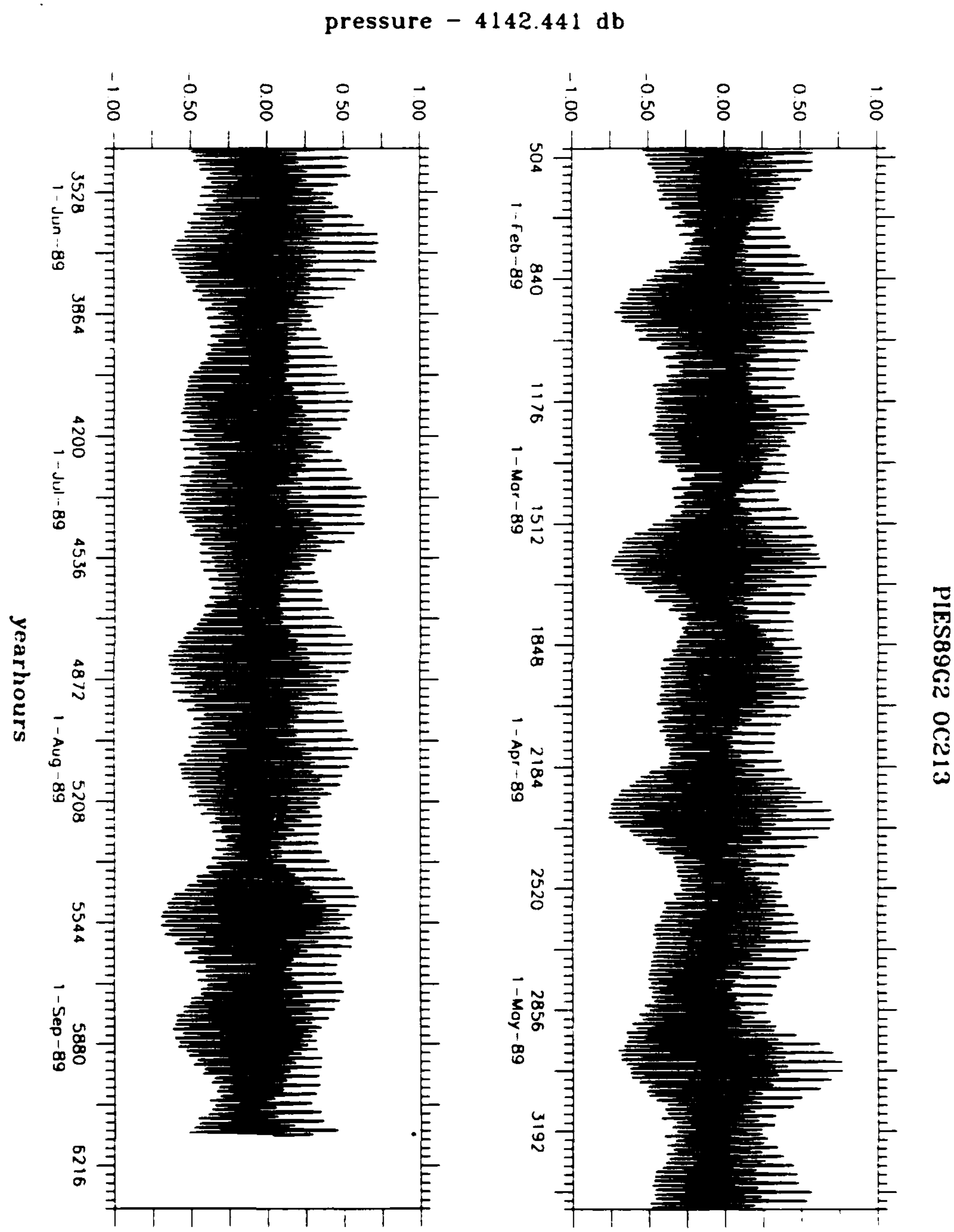


Figure 7.1: Half-Hourly Bottom Pressure. PIES89G2_213


PIES89G2 OC213
pressure - 4142.441 db
yearhours
1.00
0.50
0.00
-0.50
-1.00
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89

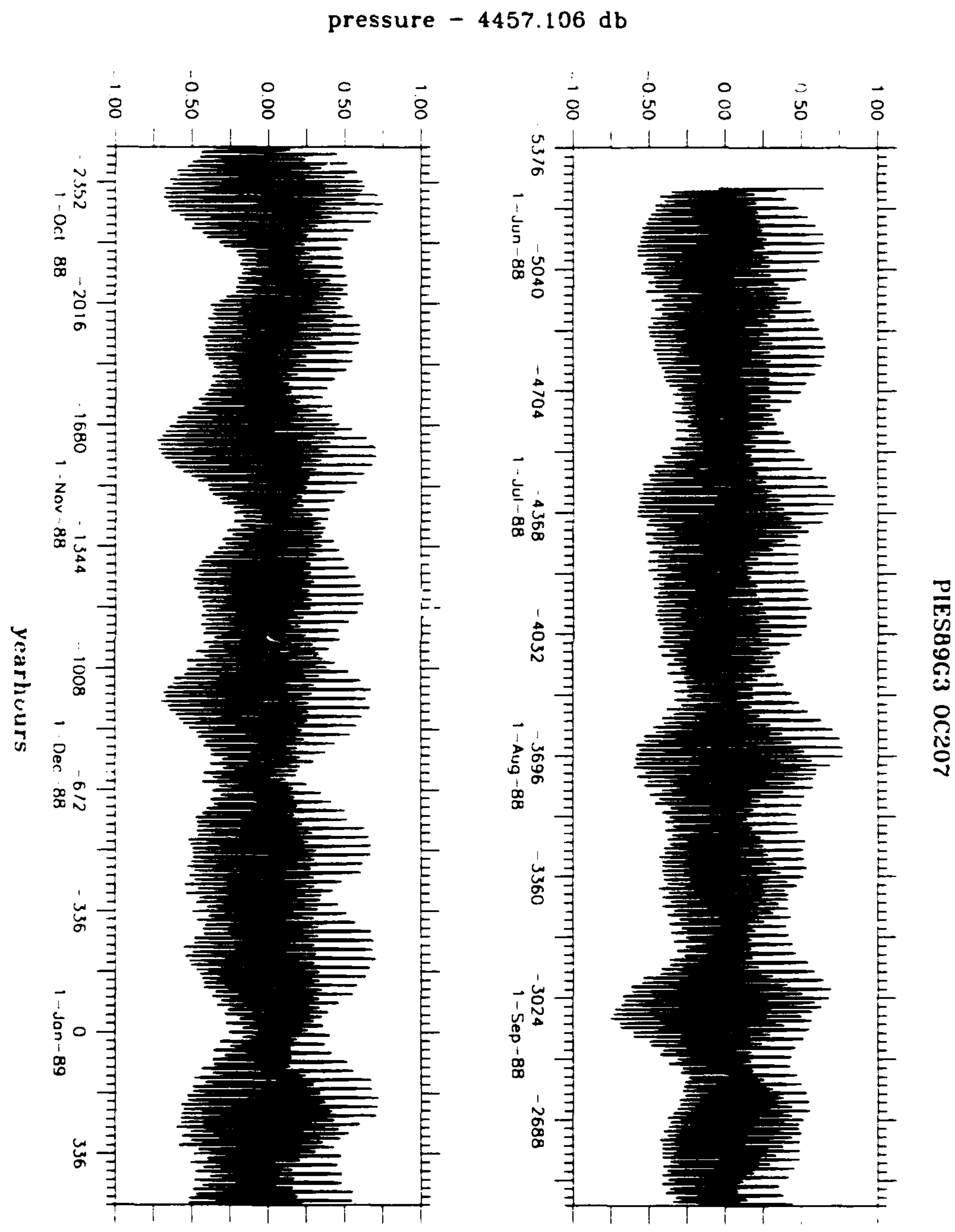
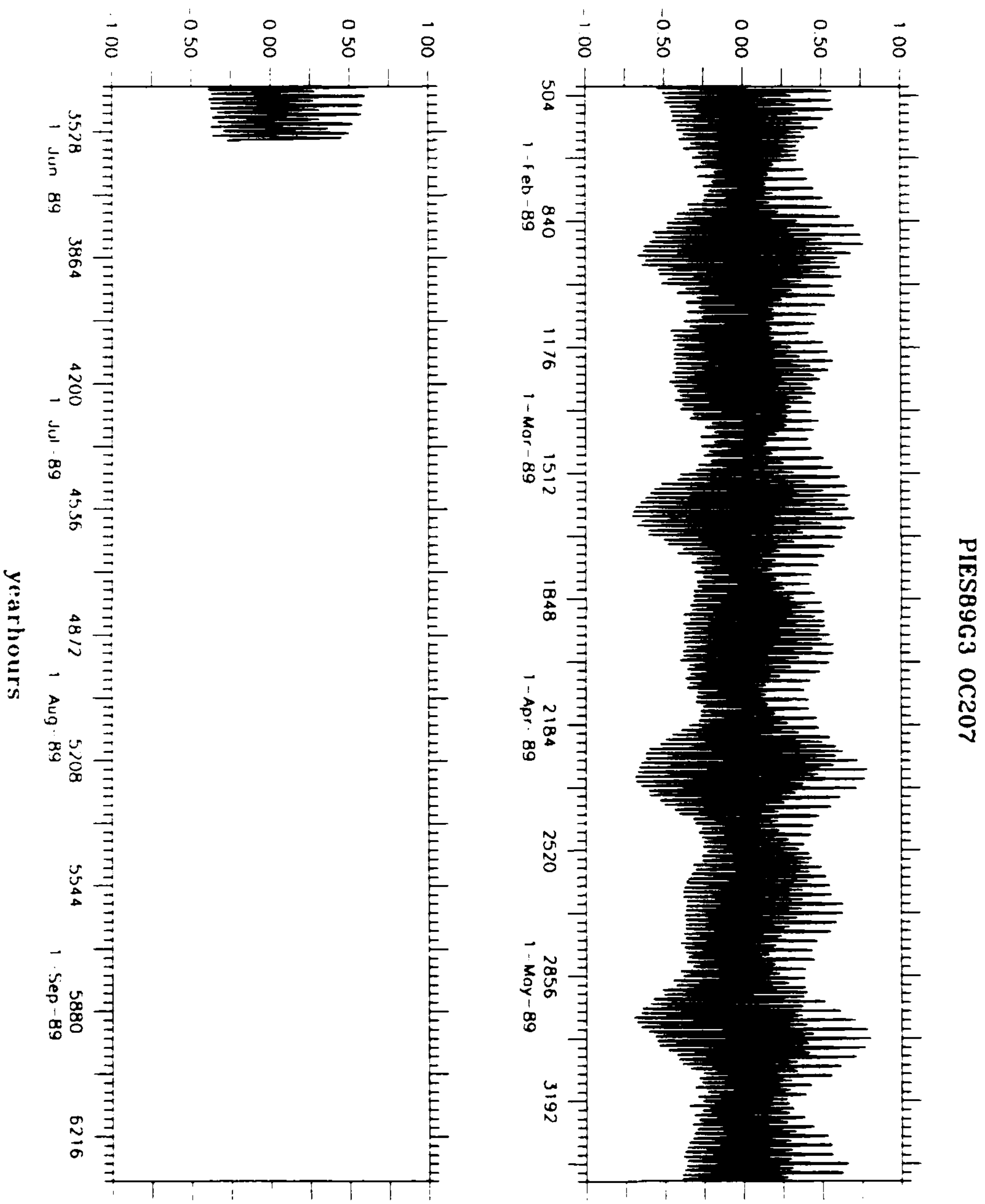


Figure 7.2: Half-Hourly Bottom Pressure. PIES89G3_207

pressure - 4457.106 db



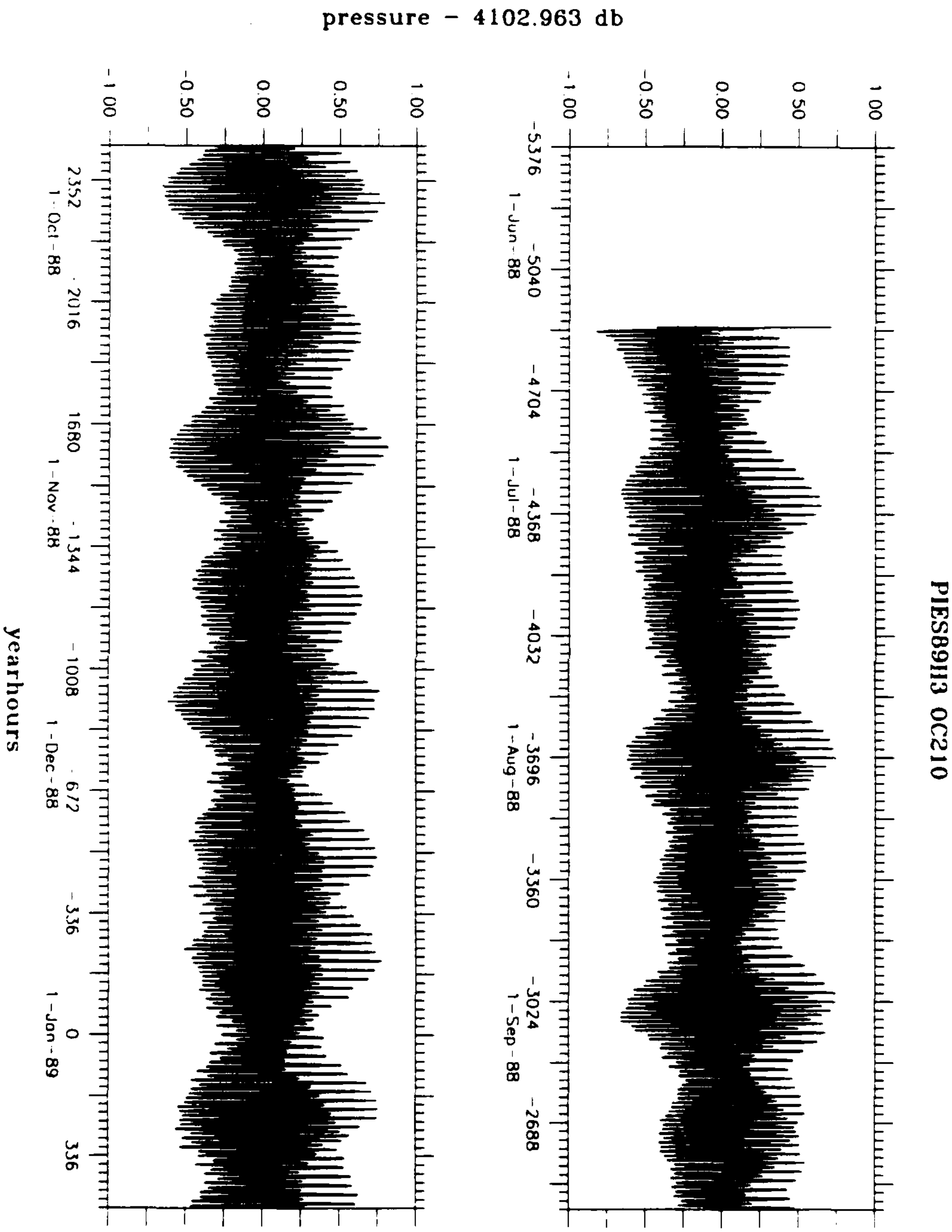
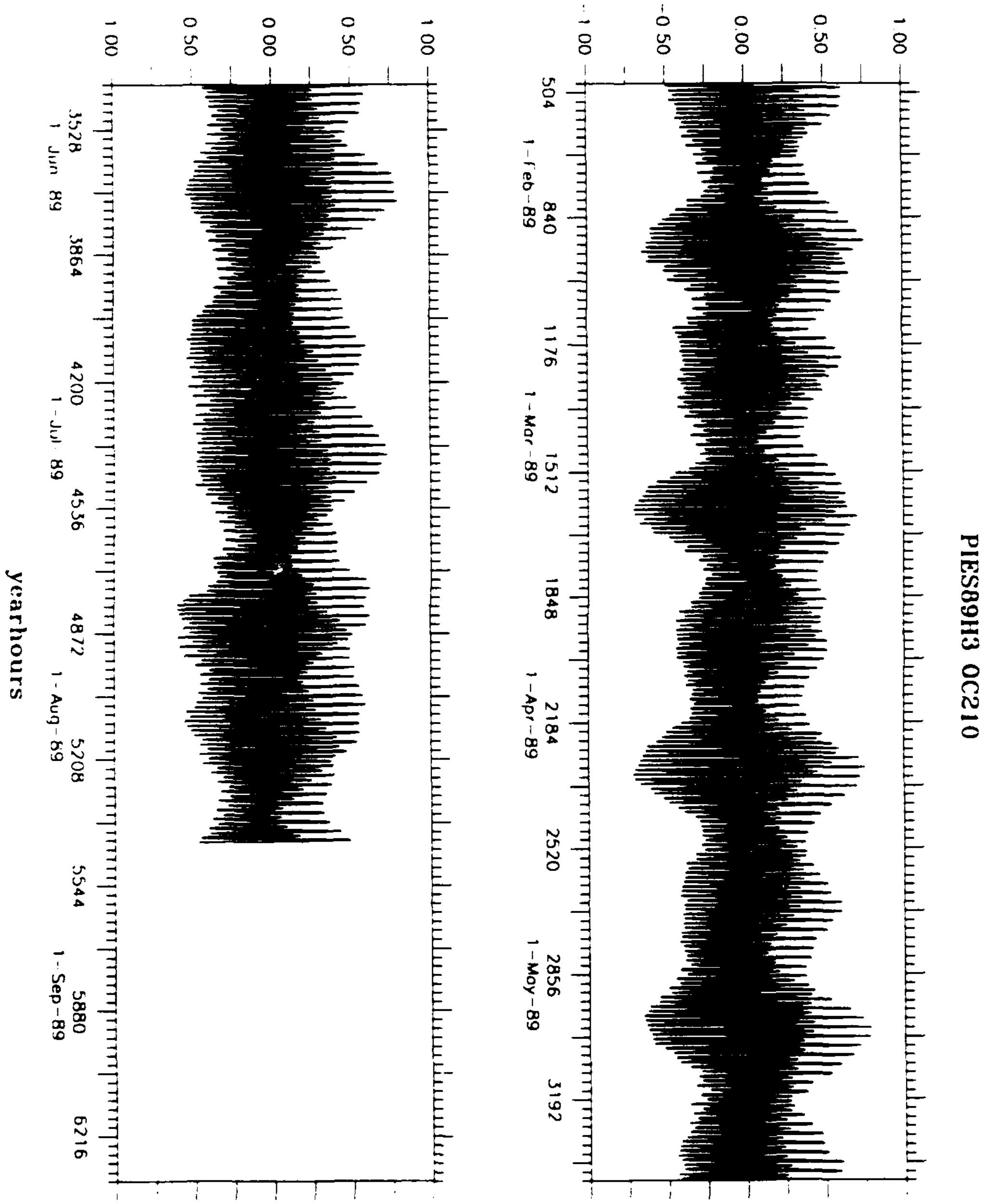


Figure 7.3: Half-Hourly Bottom Pressure: PIES89H3_210

pressure - 4102.963 db



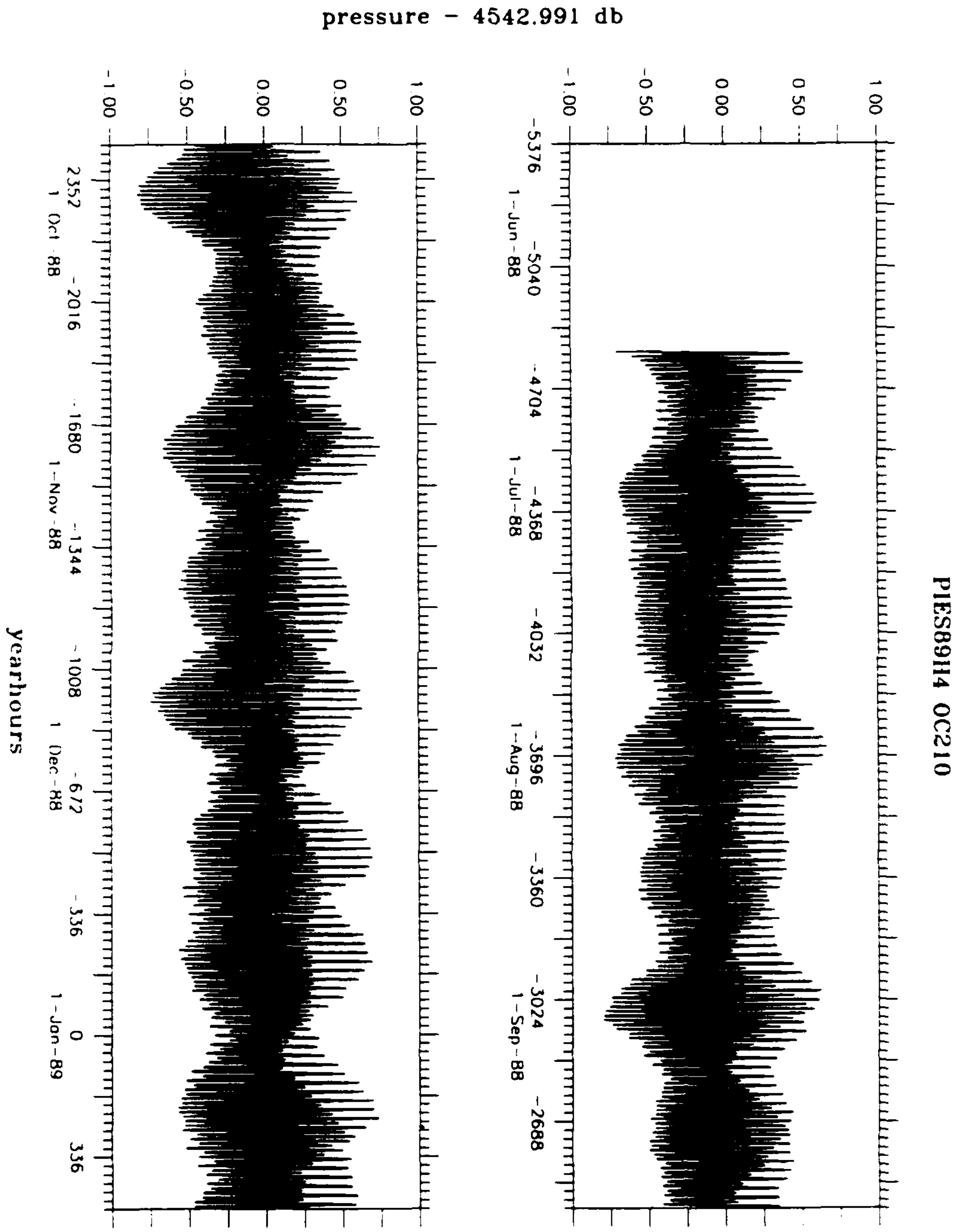
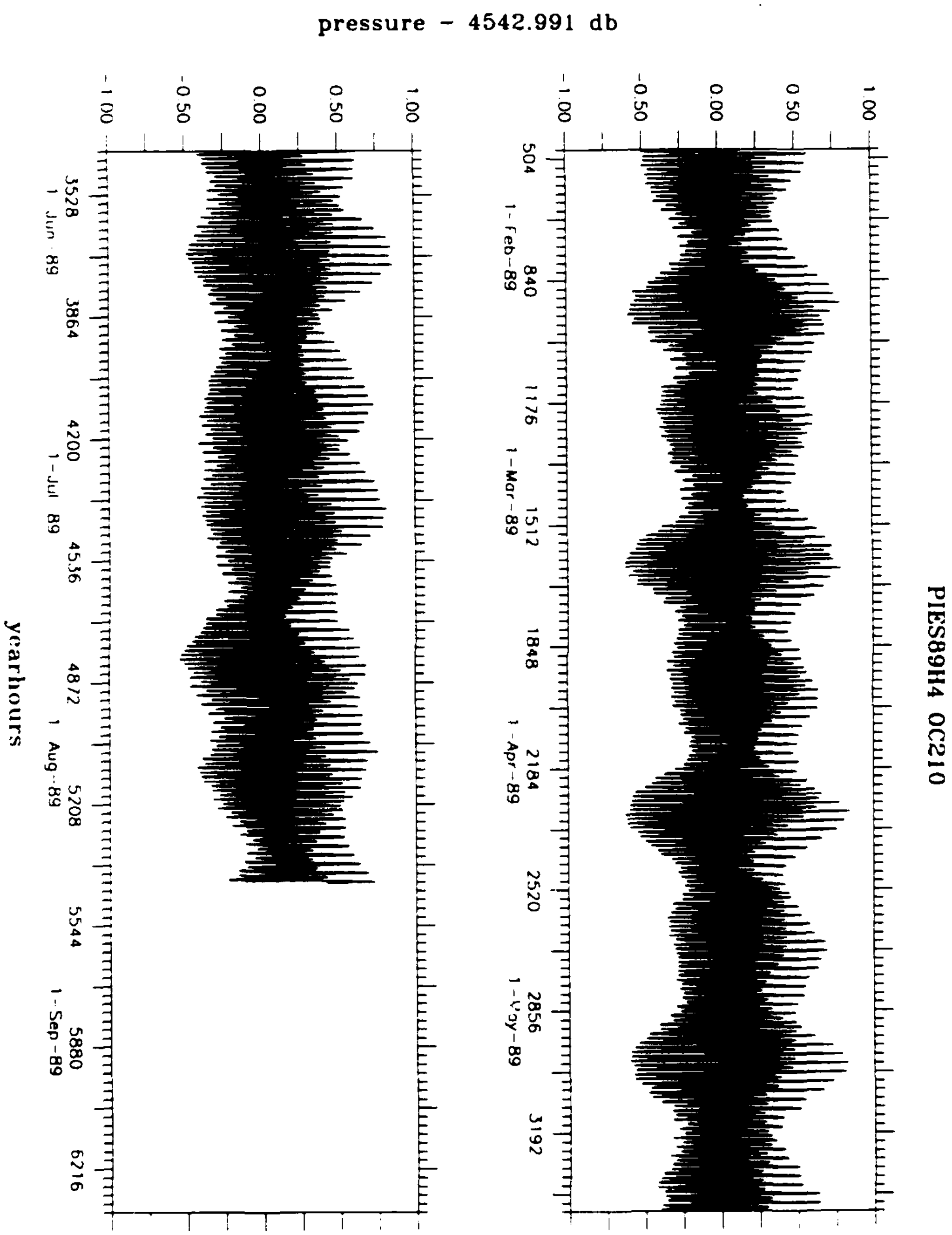


Figure 7.4: Half-Hourly Bottom Pressure. PIES89H4_210


PIES89H4 OC210
pressure - 4542.991 db
1.00
0.50
0.00
-0.50
-1.00
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jul 89
1-Aug-89
1-Sep-89
yearhours

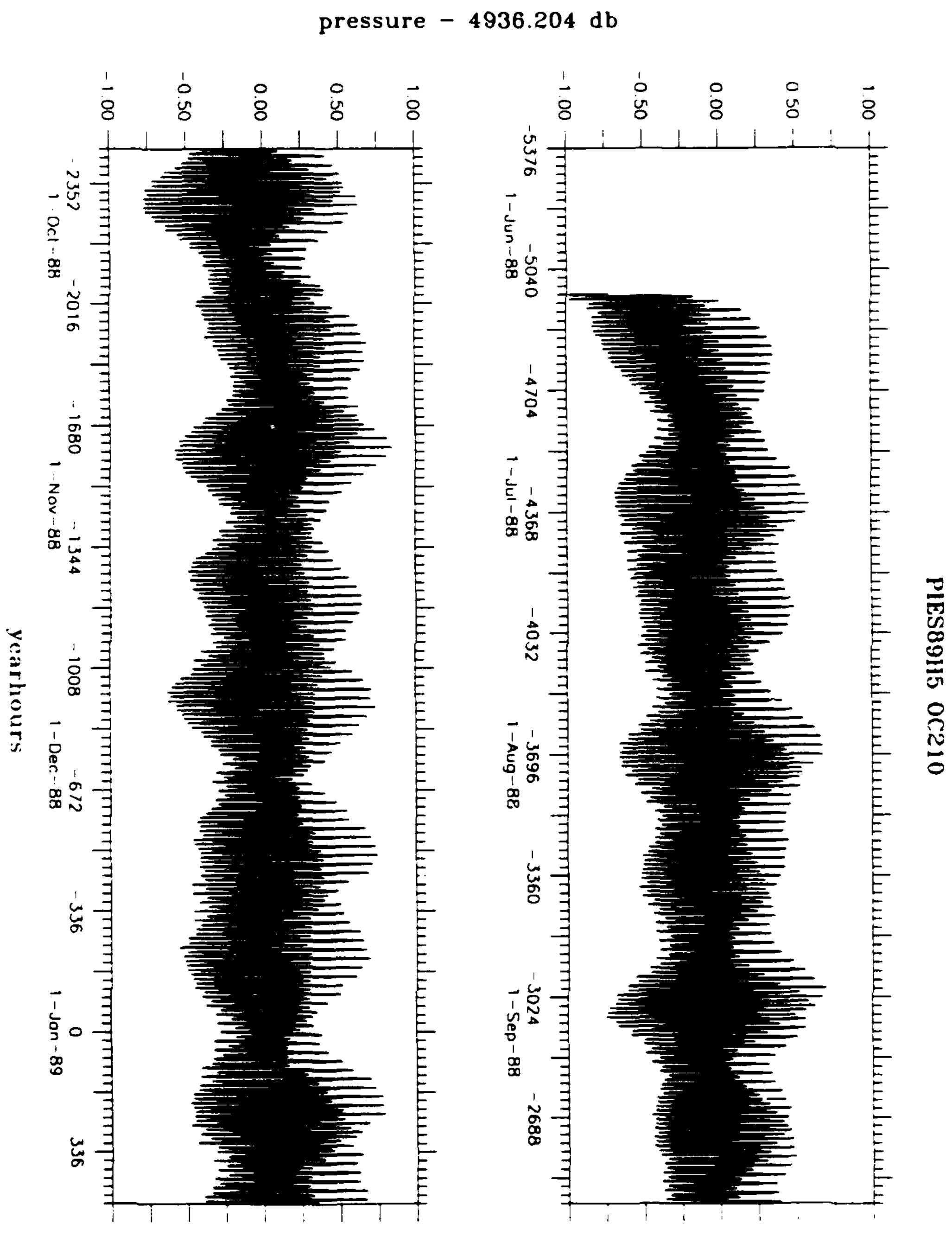
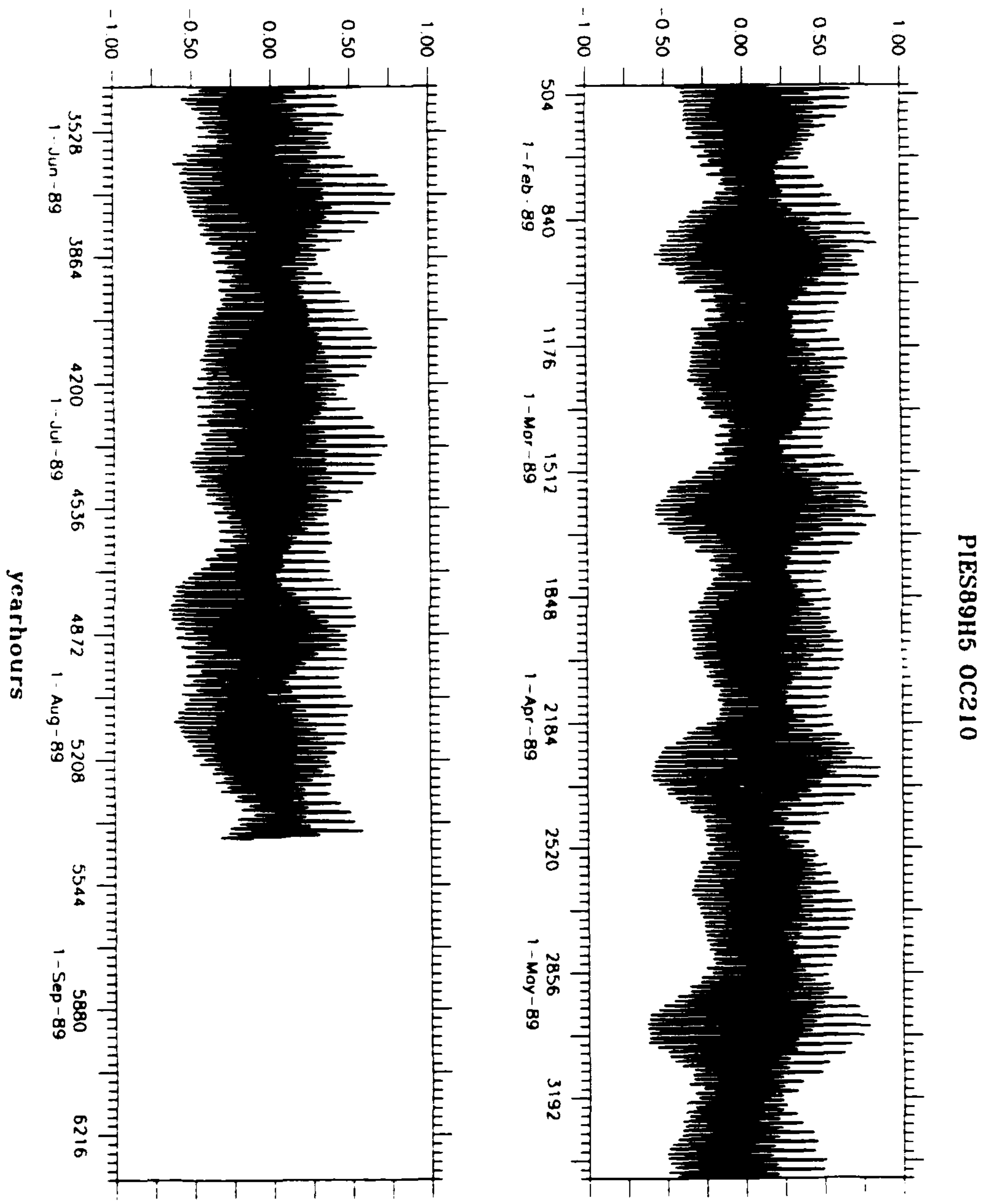


Figure 7.5: Half-Hourly Bottom Pressure. PIES89H5_210

pressure - 4936.204 db



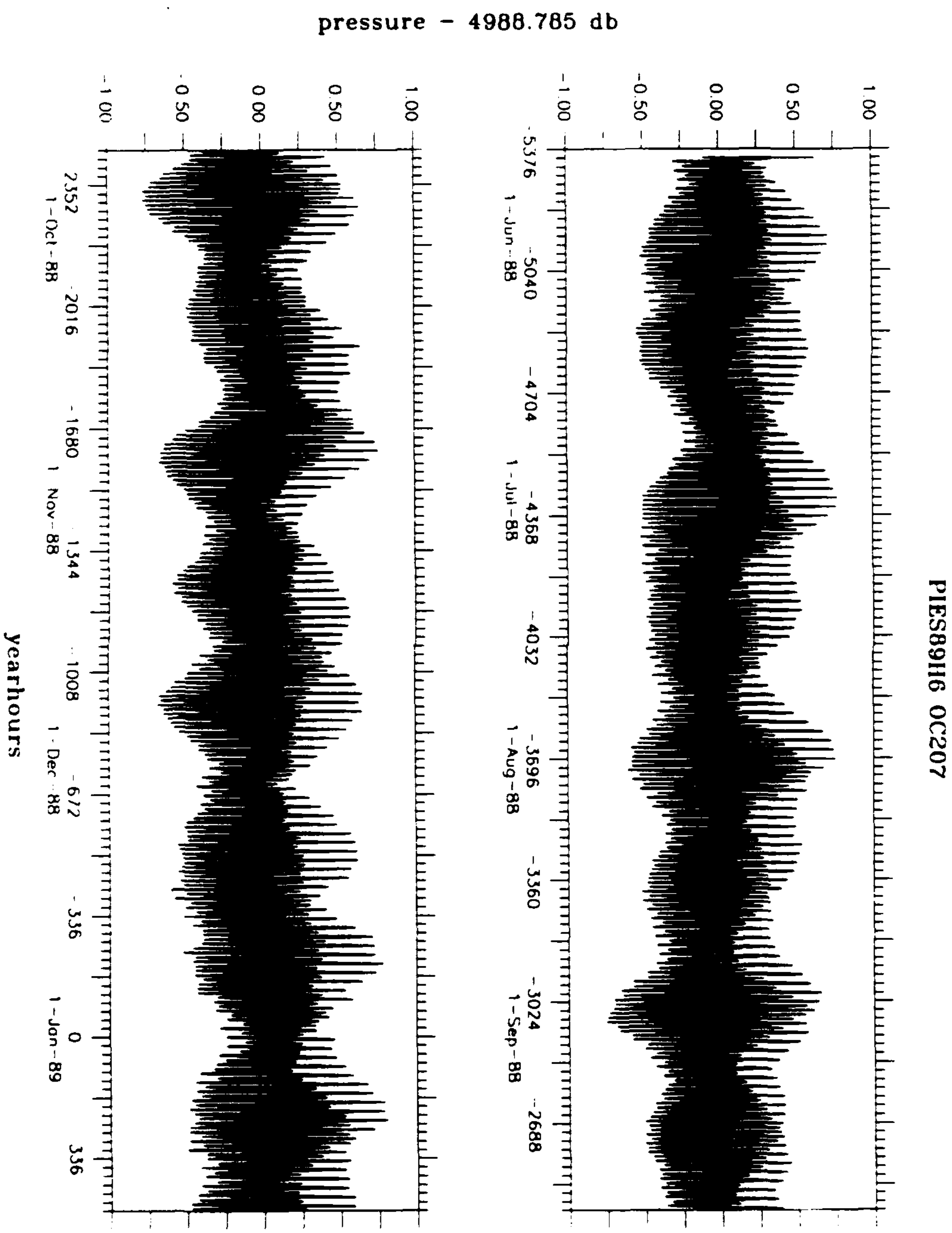
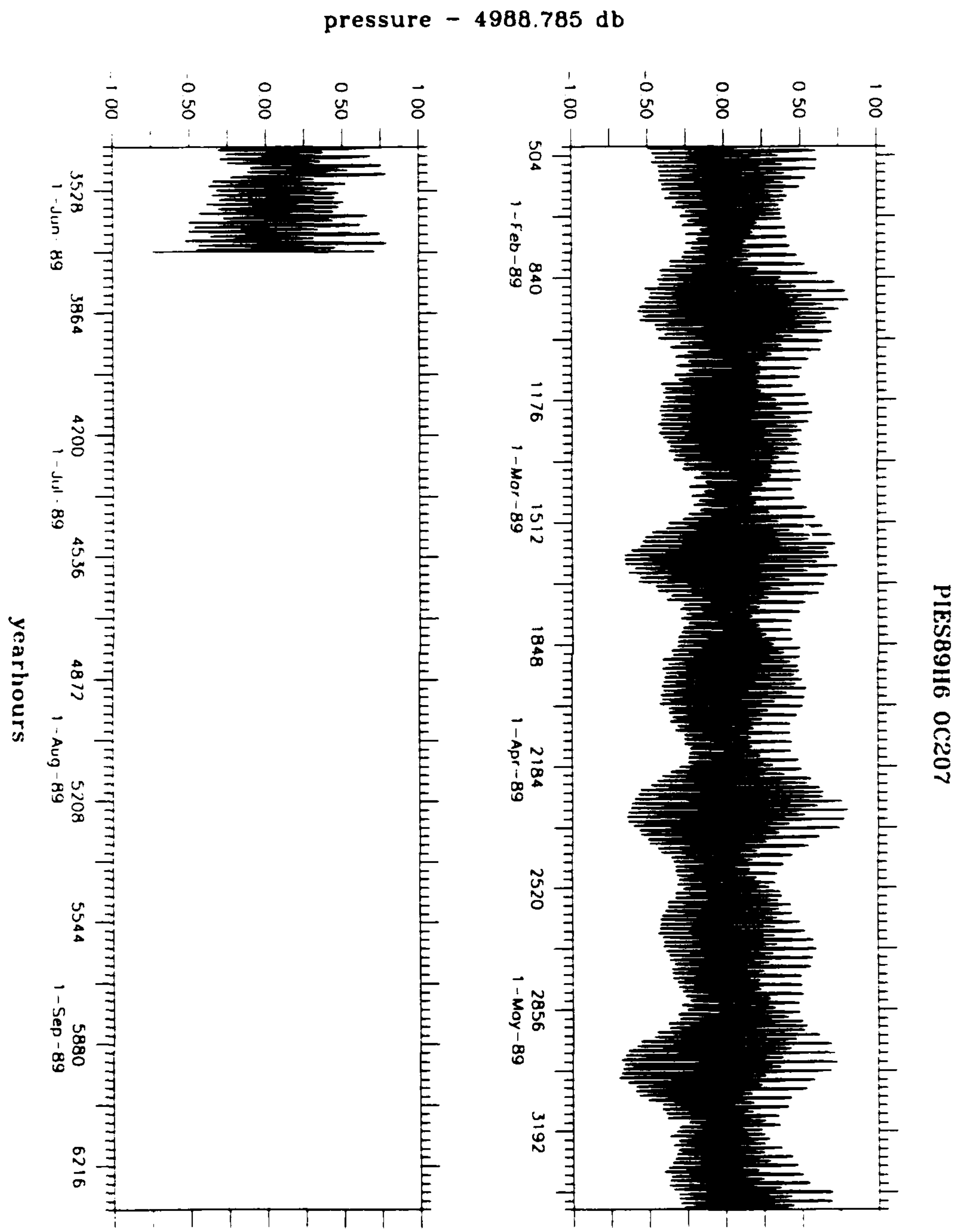


Figure 7.6: Half-Hourly Bottom Pressure. PIES89H6_207


PIES89H6 OC207
pressure - 4988.785 db
yearhours
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
504
840
1176
1512
1848
2184
2520
2856
3192
3528
3864
4200
4536
4872
5208
5544
5880
6216
-1.00
-0.50
0.00
0.50
1.00

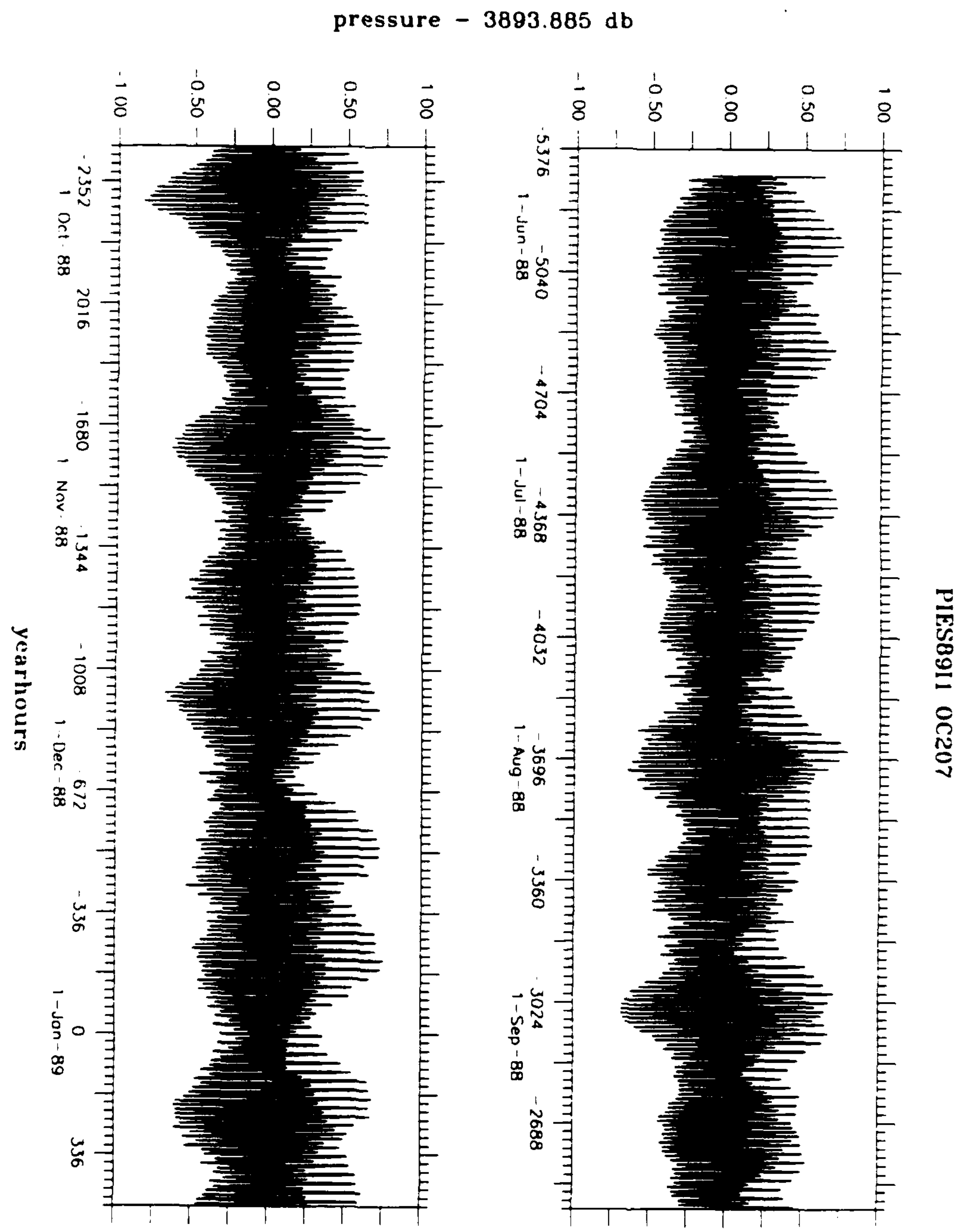
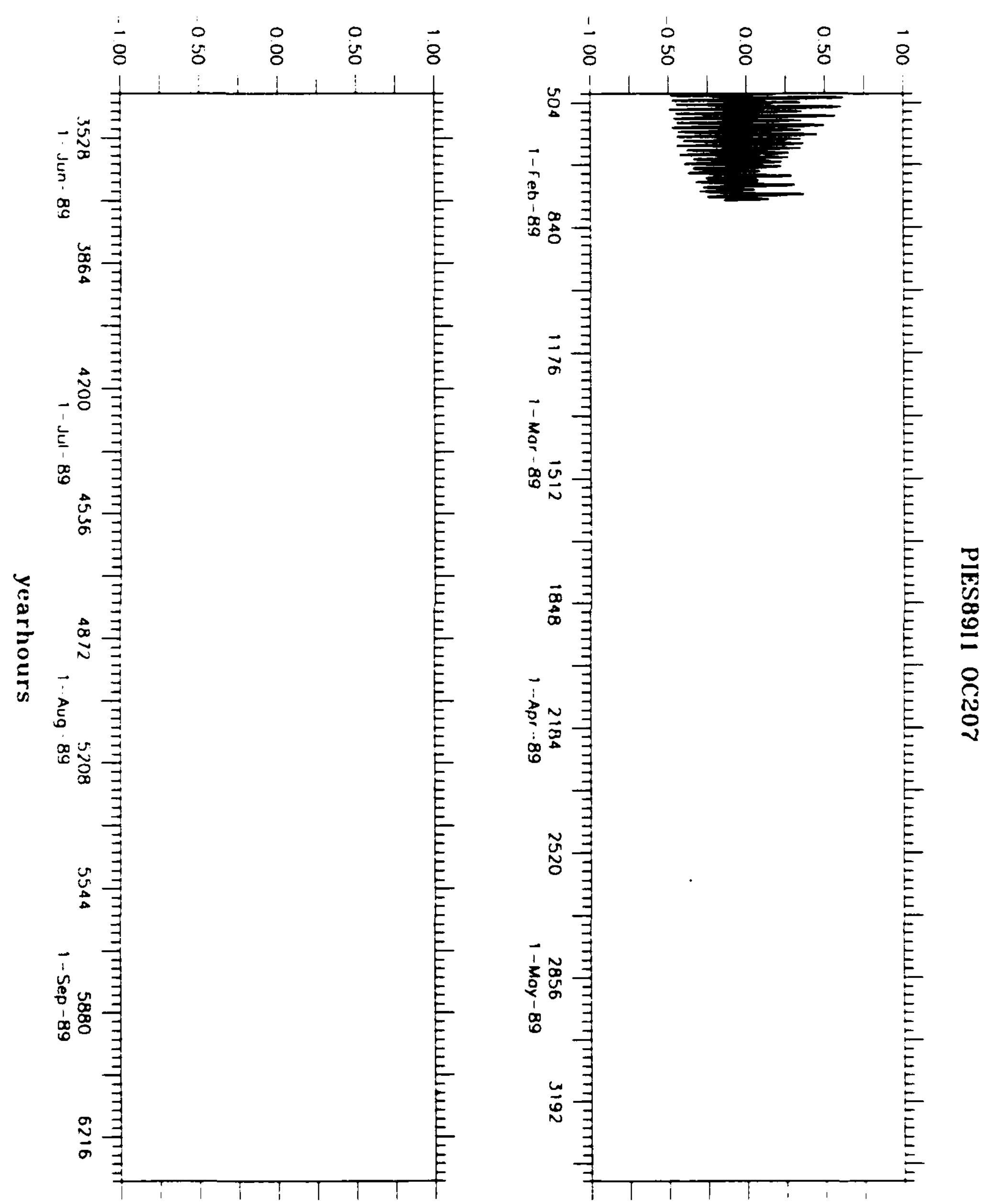


Figure 7.7: Half-Hourly Bottom Pressure. PIES89I1_207

pressure - 3893.885 db



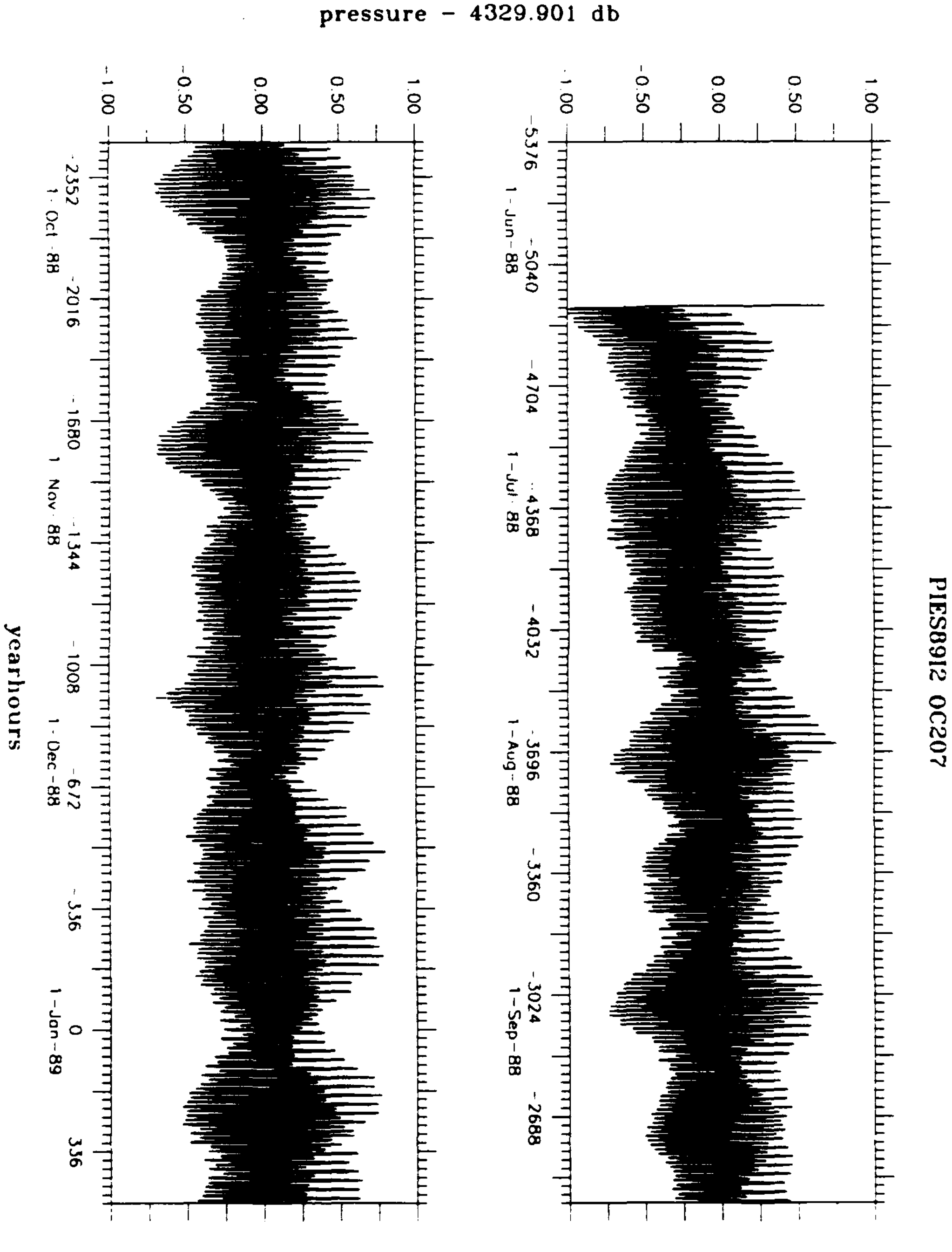
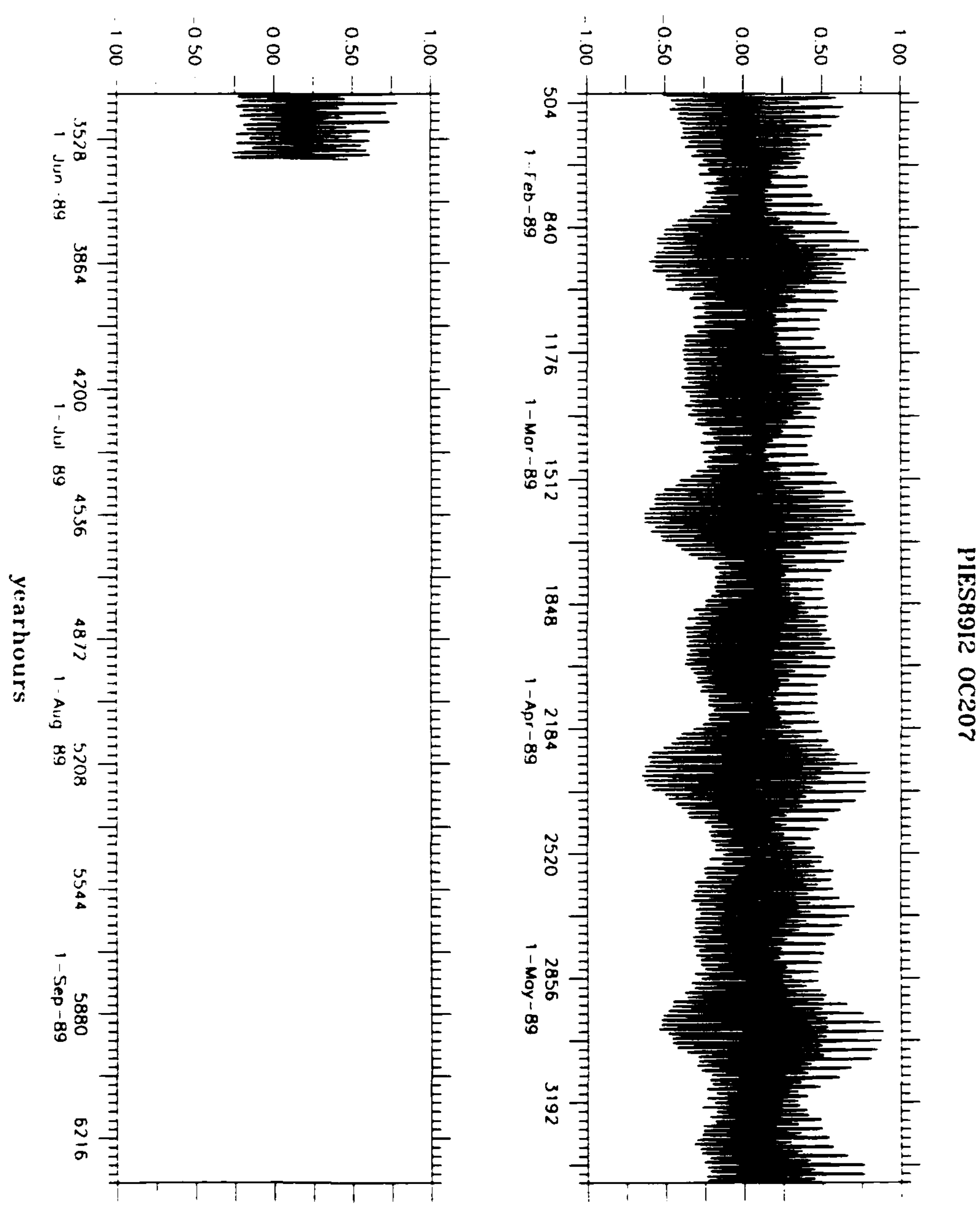


Figure 7.8: Half-Hourly Bottom Pressure. PIES89I2_207

pressure - 4329.901 db



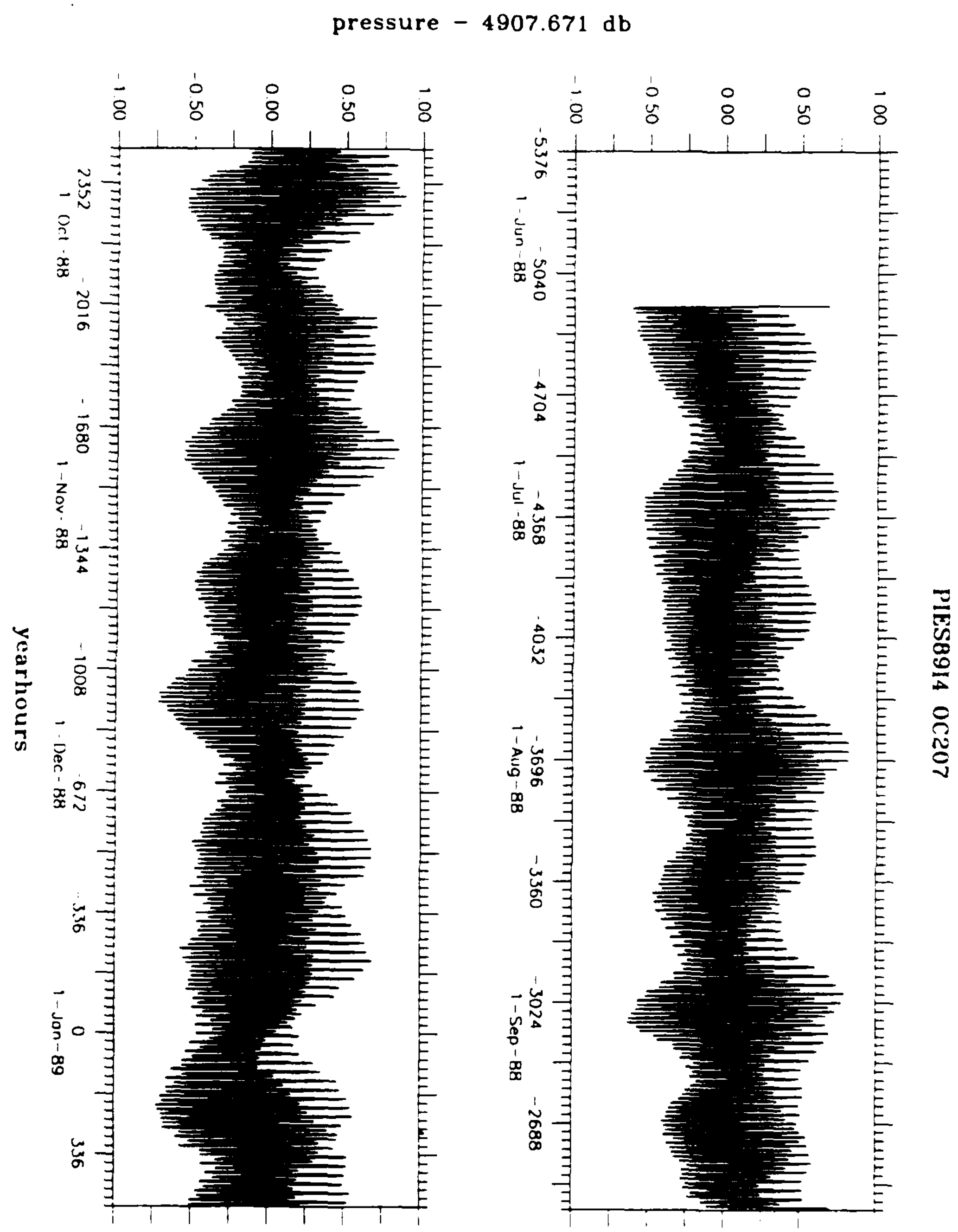
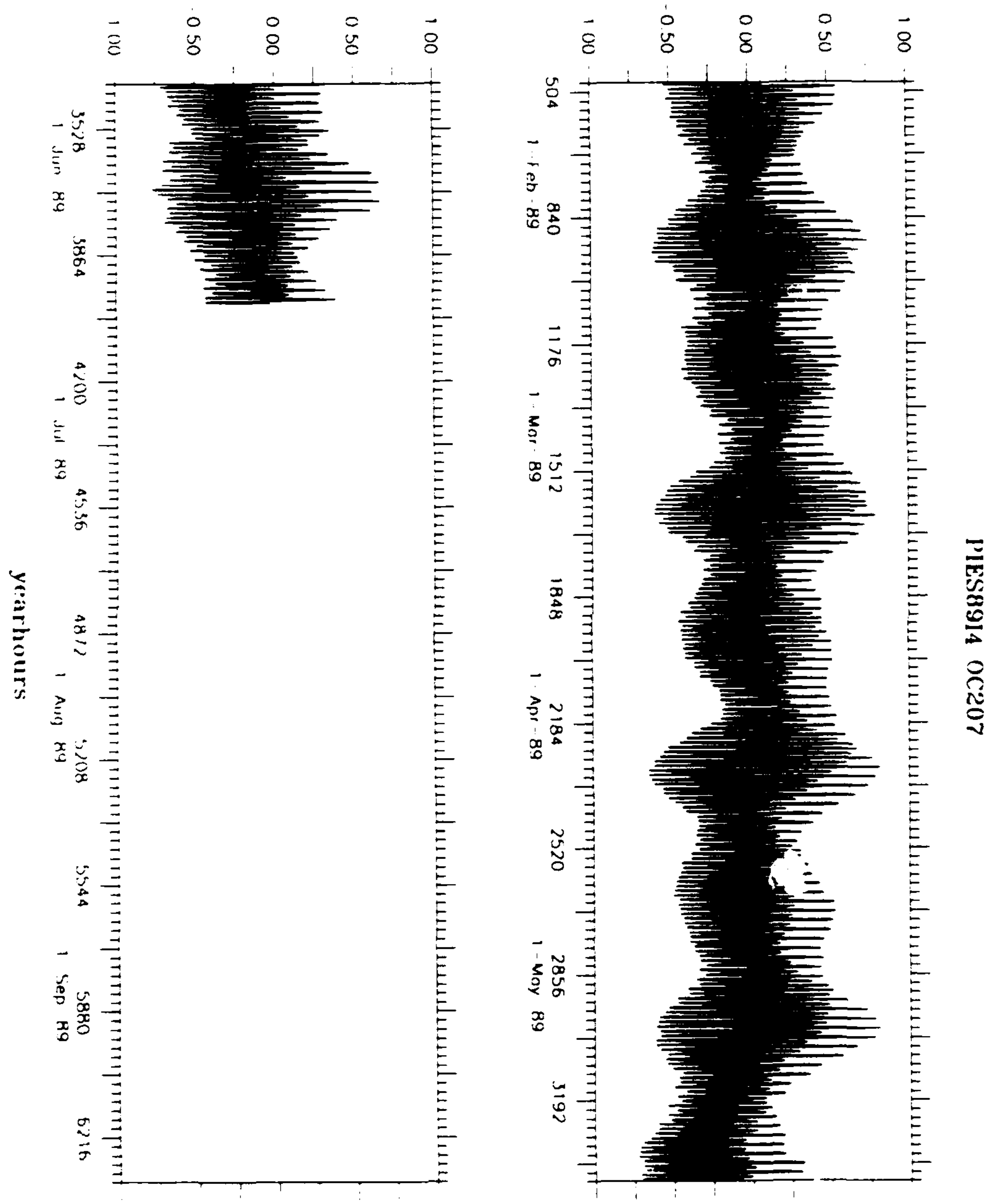


Figure 7.9: Half-Hourly Bottom Pressure. PIES89I4_207

pressure – 4907.671 db



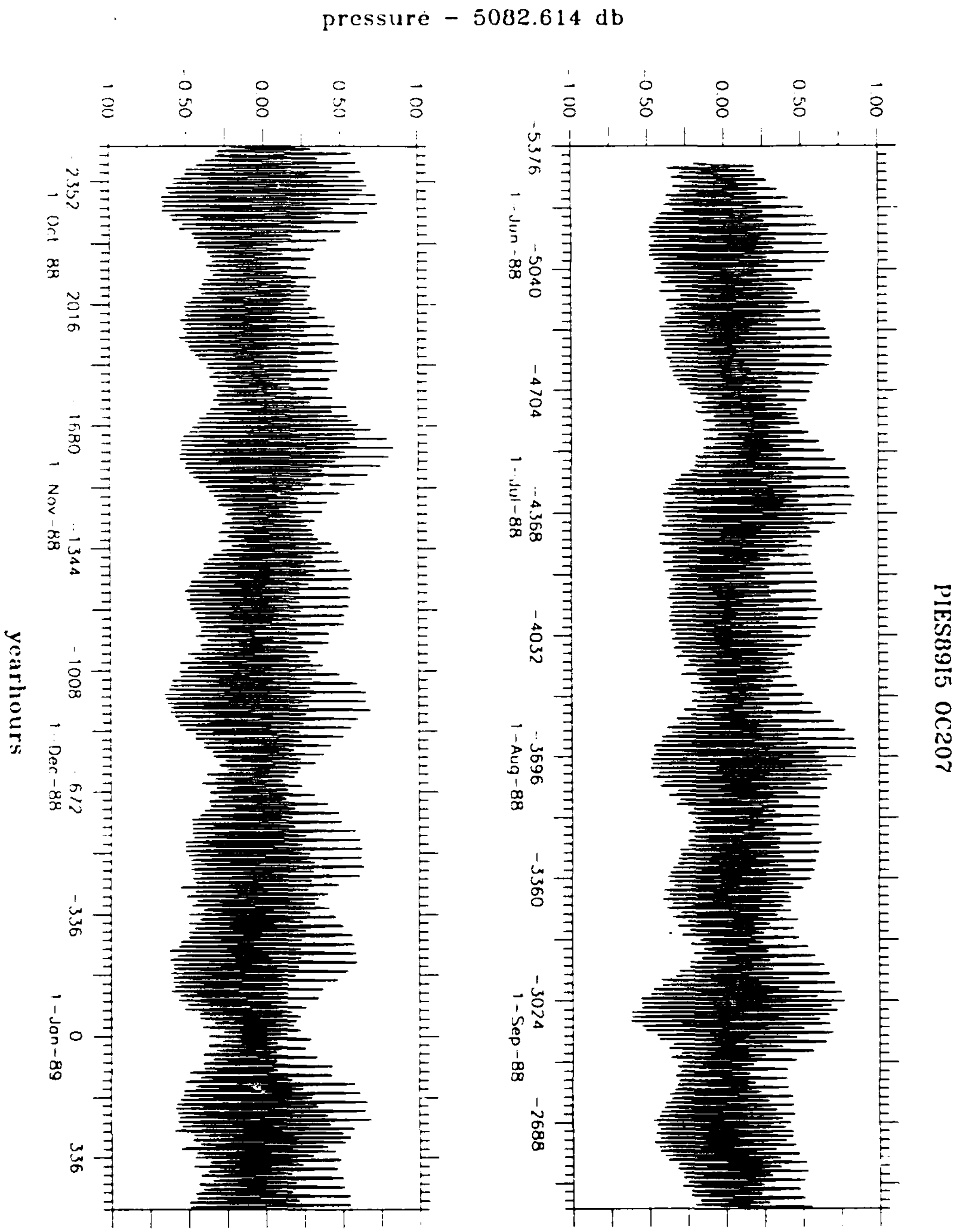
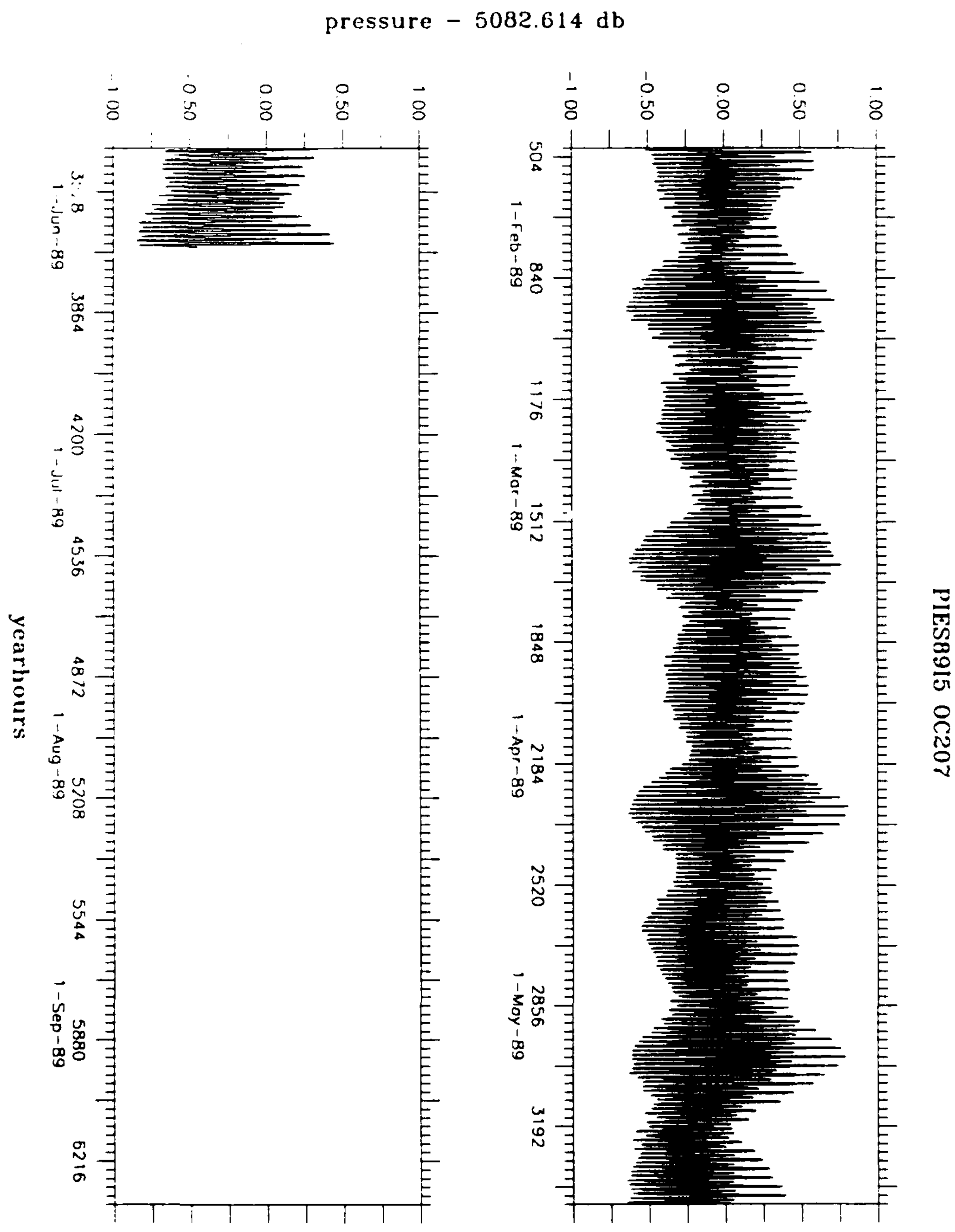


Figure 7.10: Half-Hourly Bottom Pressure. PIES89I5_207



PIES8915 OC207
pressure - 5082.614 db
yearhours
1.00
0.50
0.00
-0.50
-1.00
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89

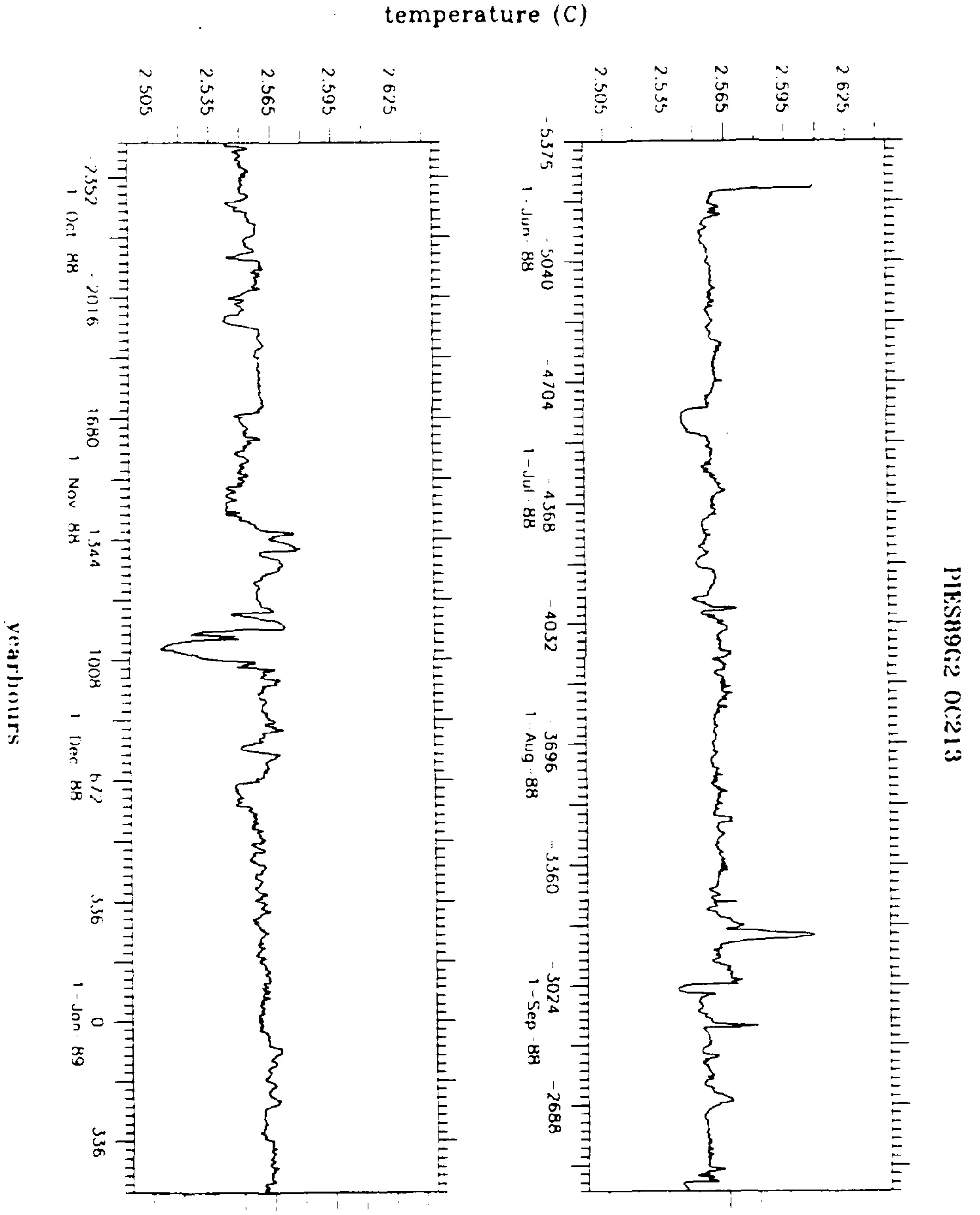
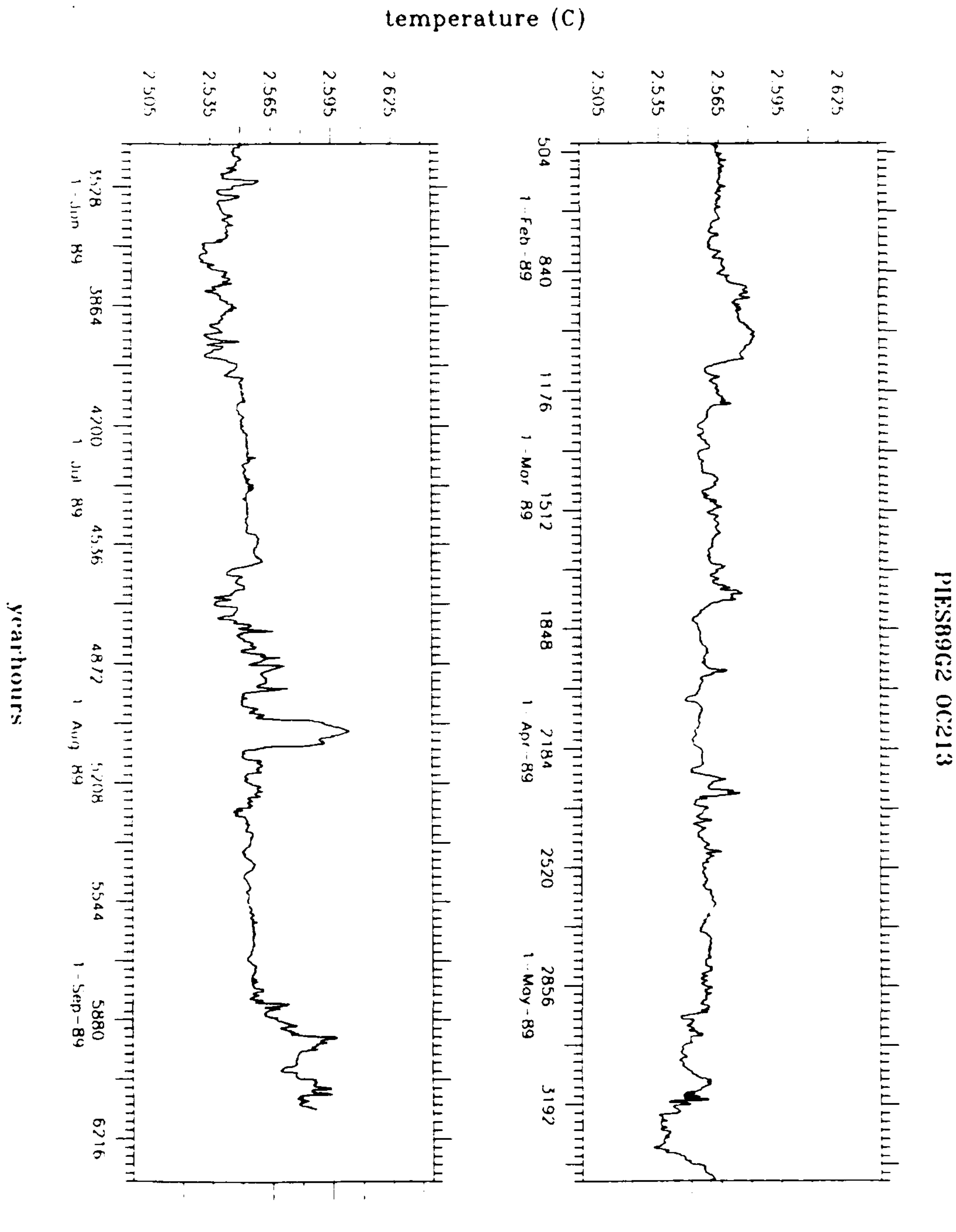


Figure 8.1: Half-Hourly Temperature. PIES89G2_213


PIES89G2 OC213
temperature (C)
2.625
2.595
2.565
2.535
2.505
504
840
1 - Feb - 89
1176
1512
1 - Mar - 89
1848
2184
1 - Apr - 89
2520
2856
1 - May - 89
3192
3528
1 - Jun - 89
3864
4200
1 - Jul - 89
4536
4872
1 - Aug - 89
5208
5544
5880
1 - Sep - 89
6216
yearhours

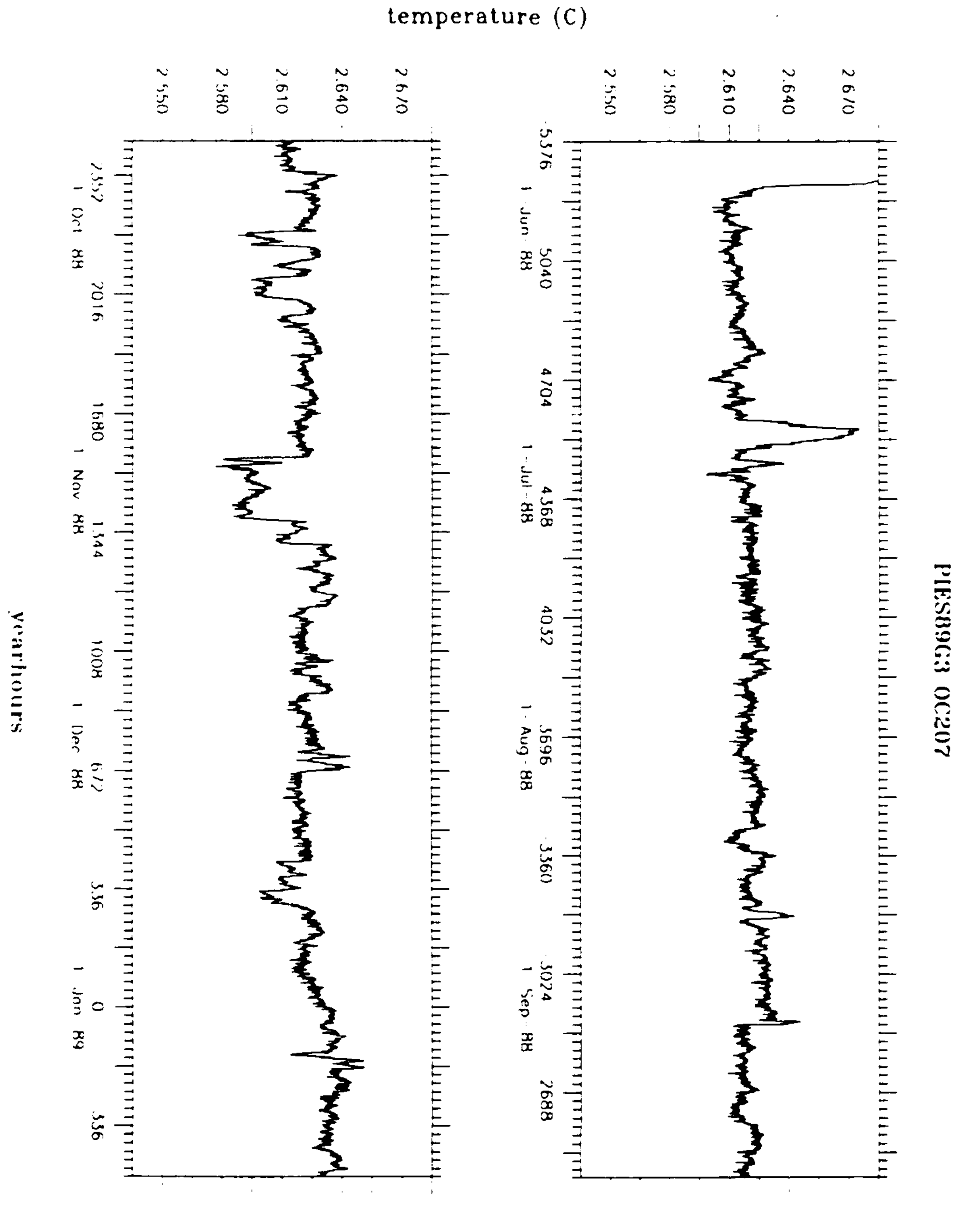
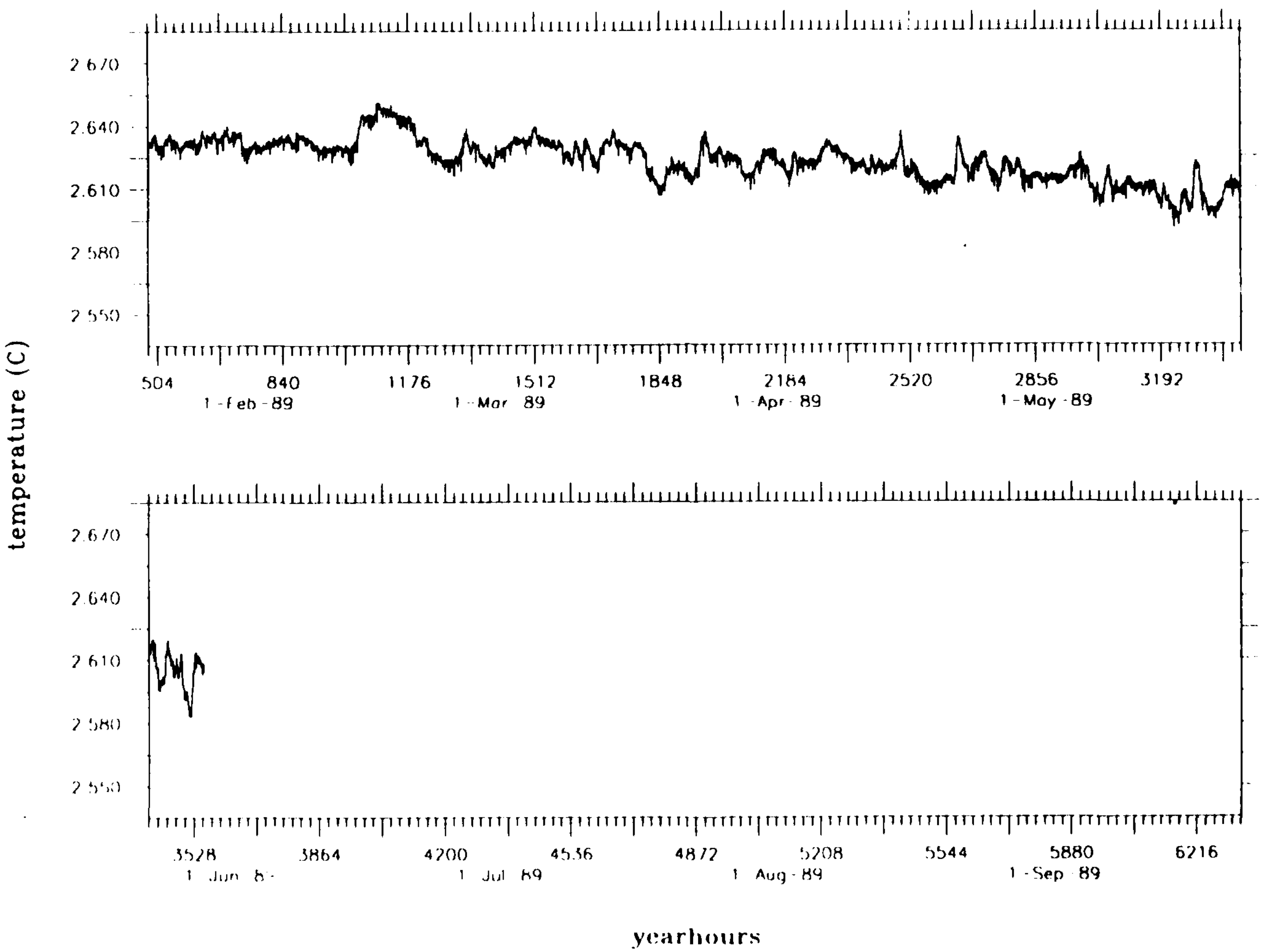


Figure 8.2: Half-Hourly Temperature. PIES89G3_207

PIES89G3 OC207



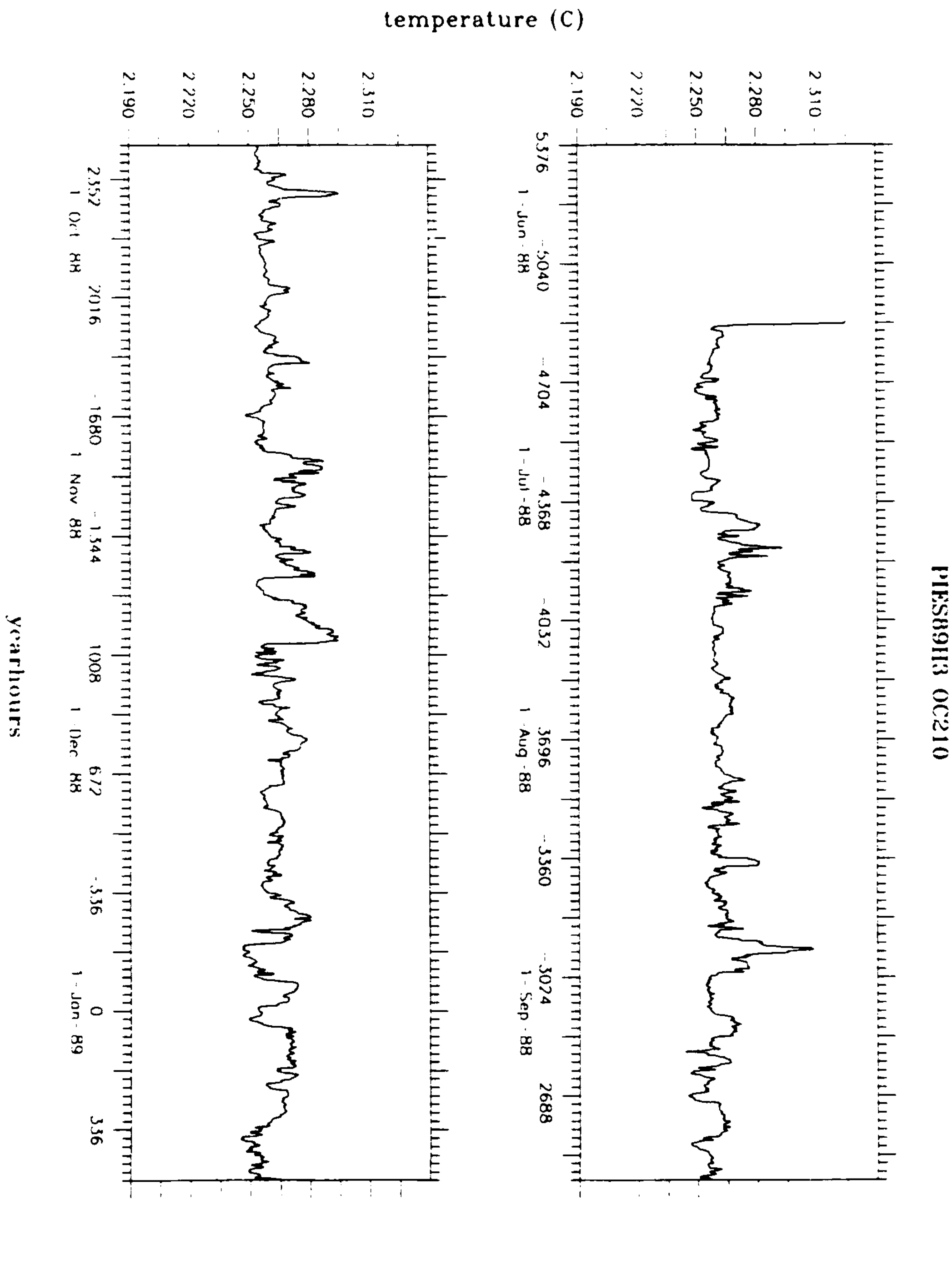
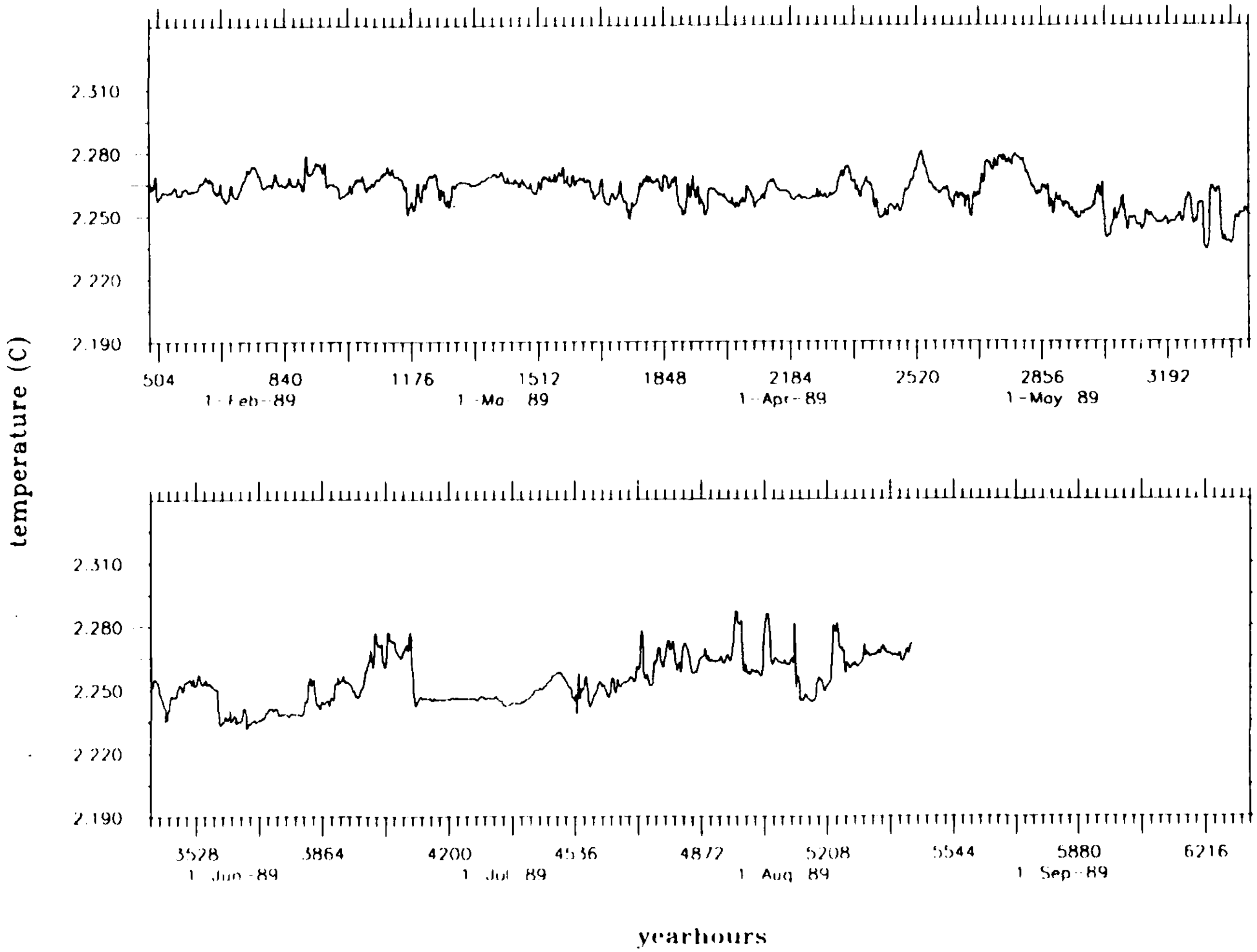


Figure 8.3: Half-Hourly Temperature. PIES89H3_210

PIES89H3 OC210



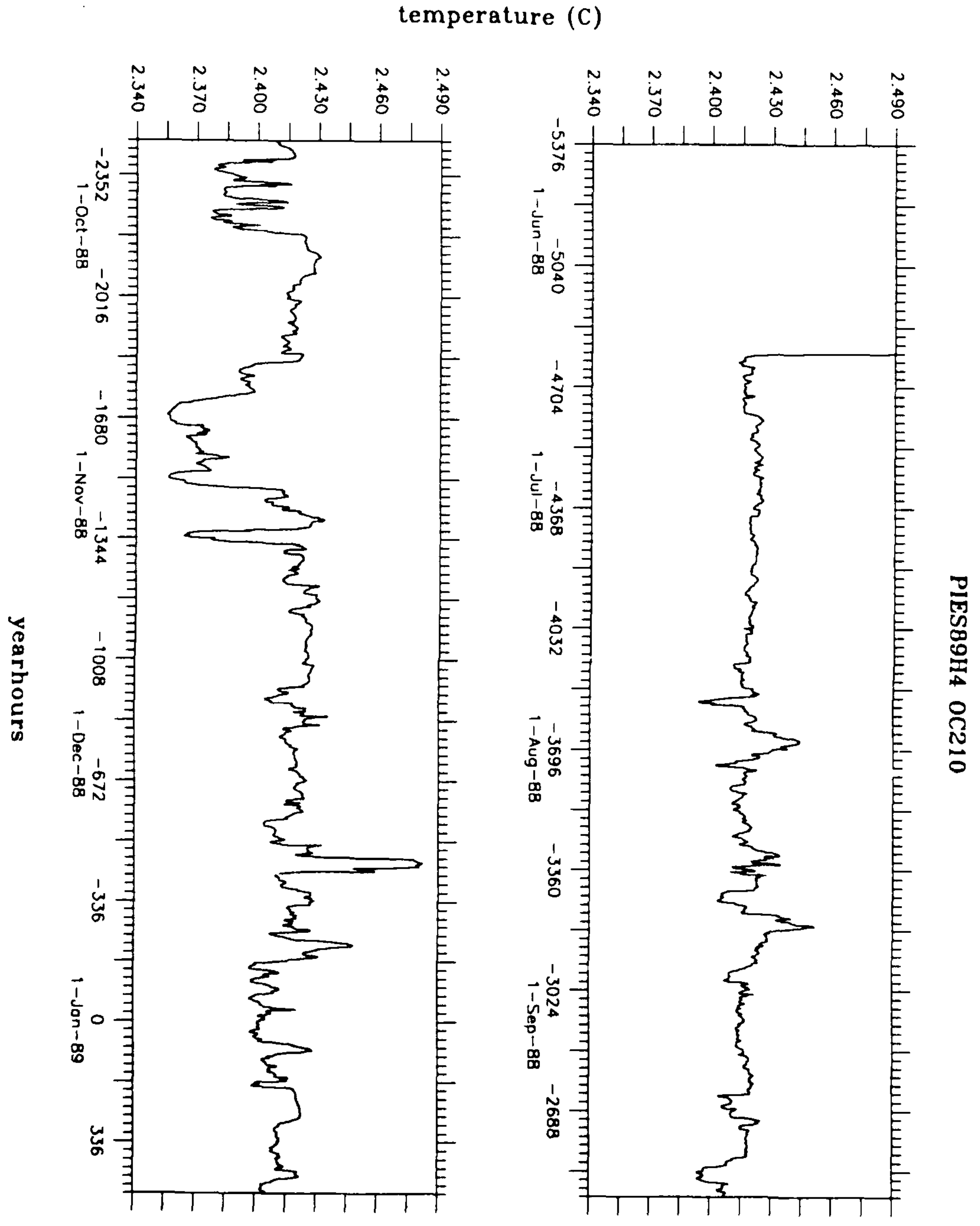
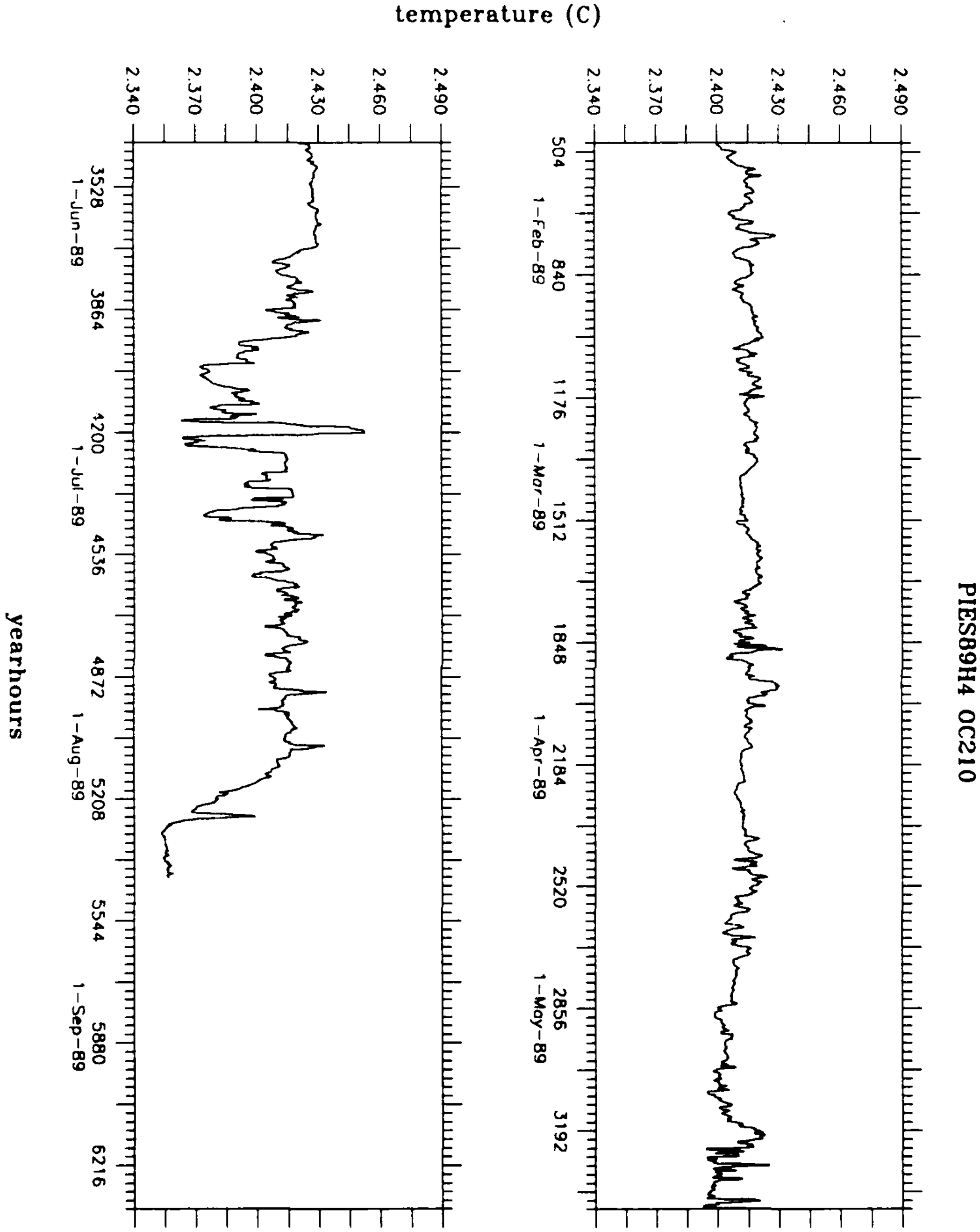


Figure 8.4: Half-Hourly Temperature. PIES89H4_210


PIES89H4 OC210
temperature (C)
2.340
2.370
2.400
2.430
2.460
2.490
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

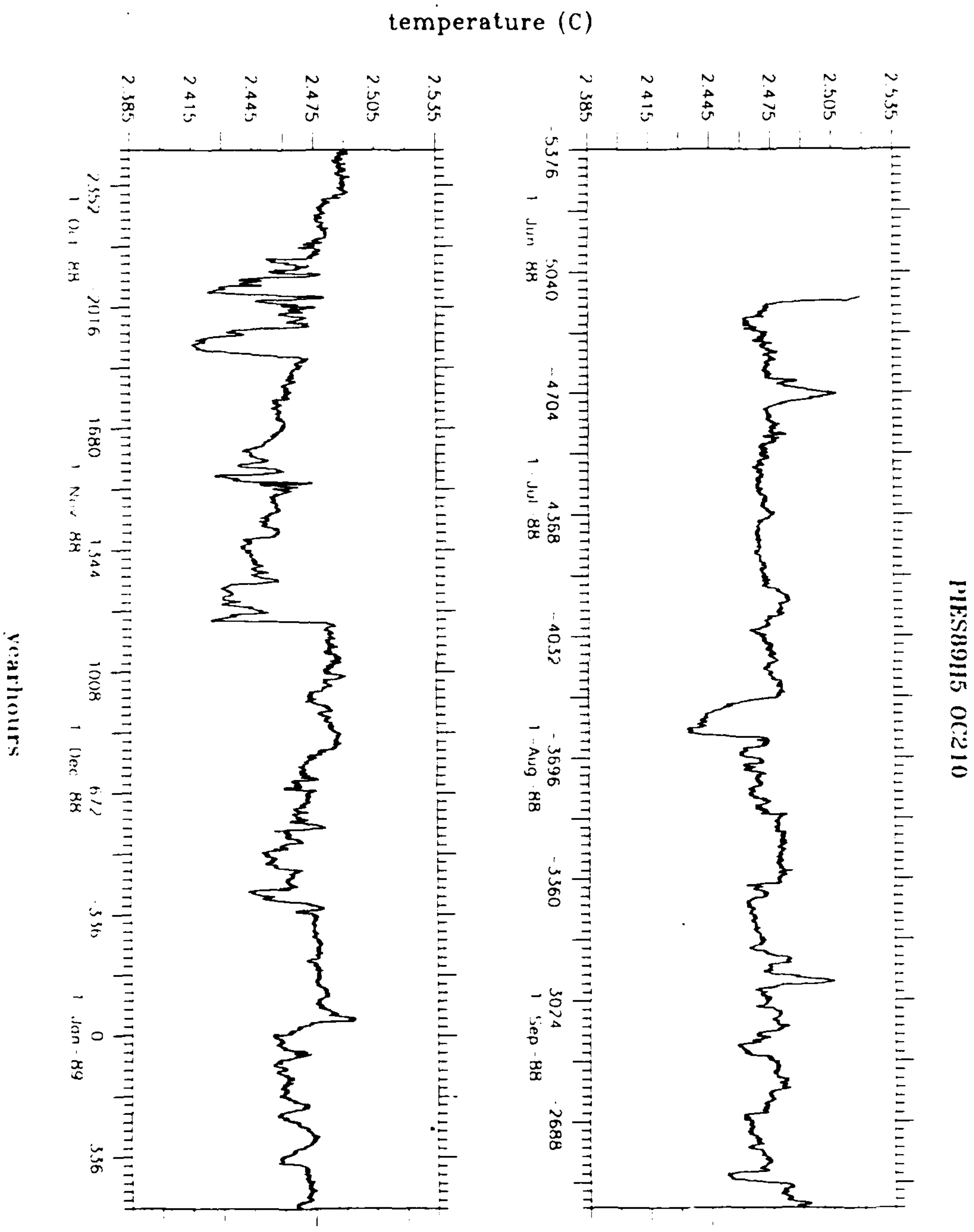
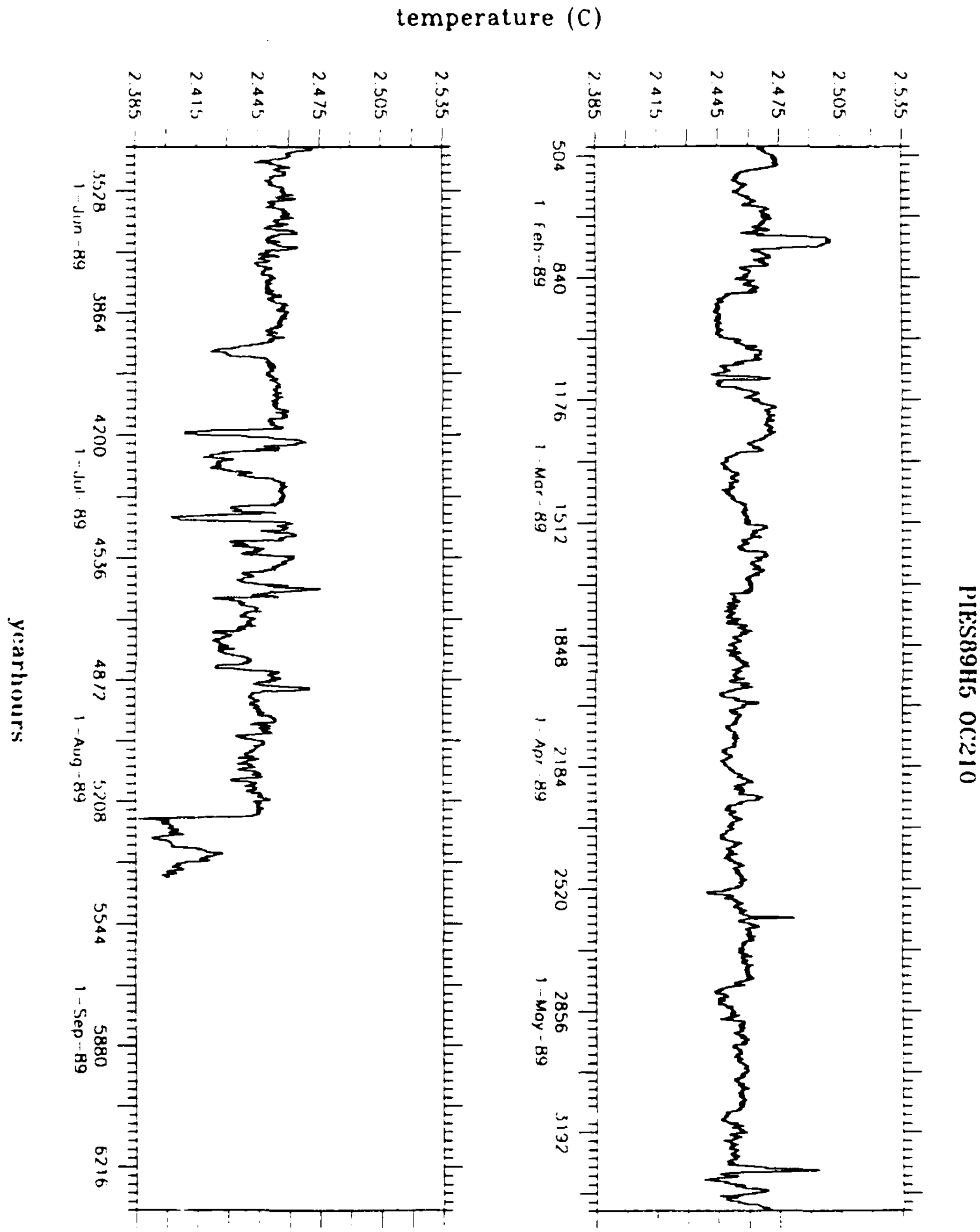


Figure 8.5: Half-Hourly Temperature. PIES89H5_210


PIES89H5 OC210
temperature (C)
yearhours
2.385
2.415
2.445
2.475
2.505
2.535
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89

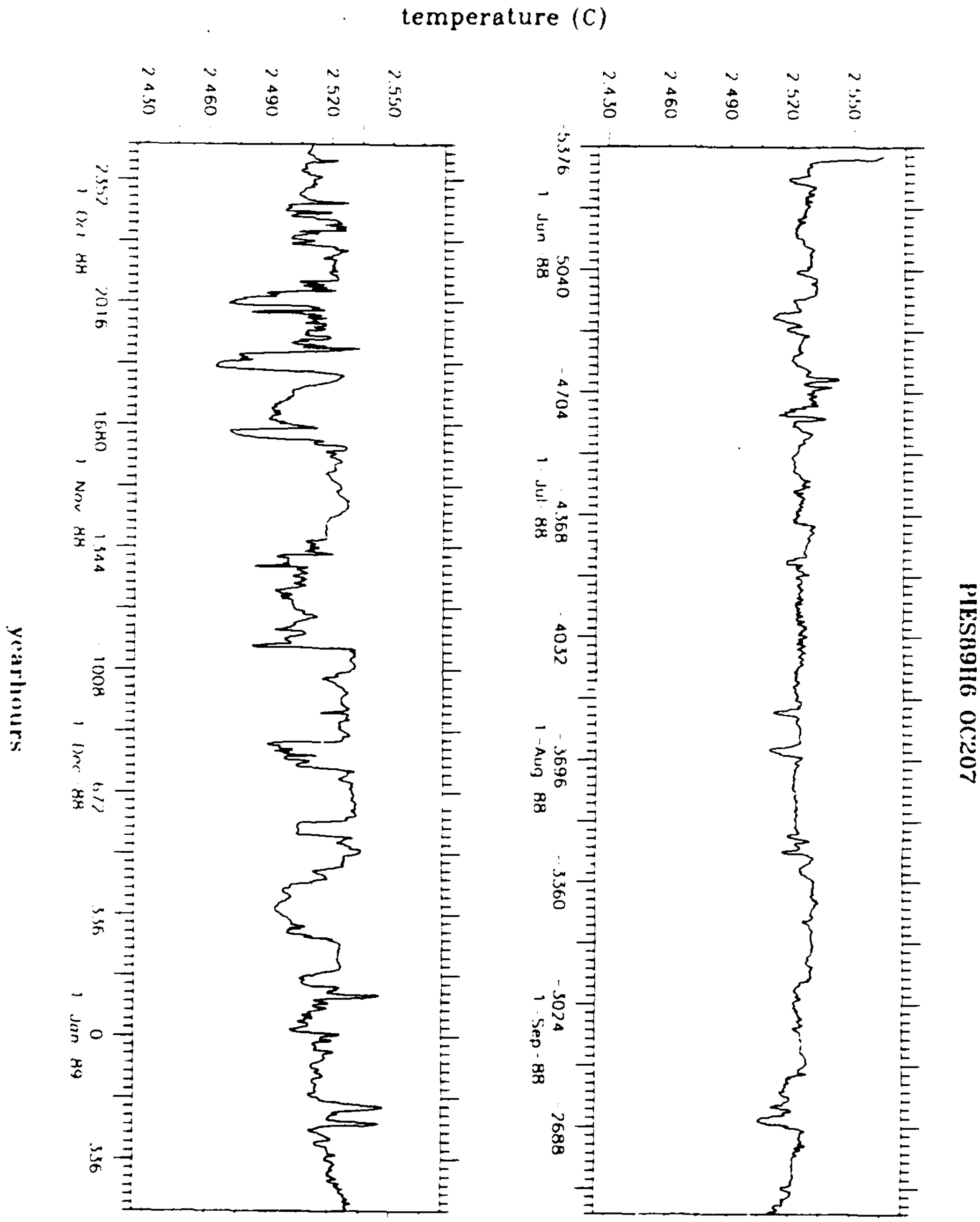
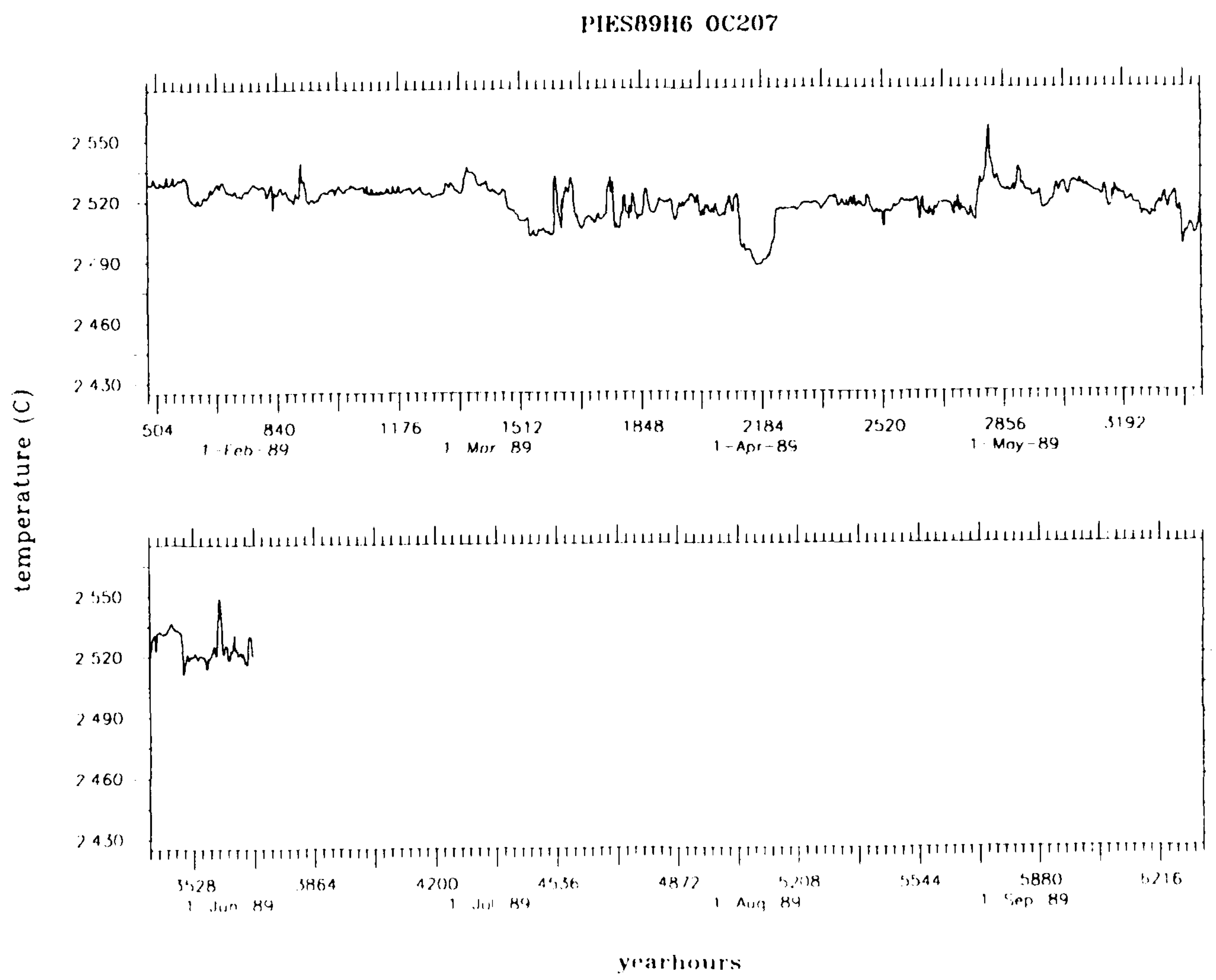


Figure 8.6: Half-Hourly Temperature. PIES89H6_207


PIES89H6 OC207
temperature (C)
2.550
2.520
2.490
2.460
2.430
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89
yearhours

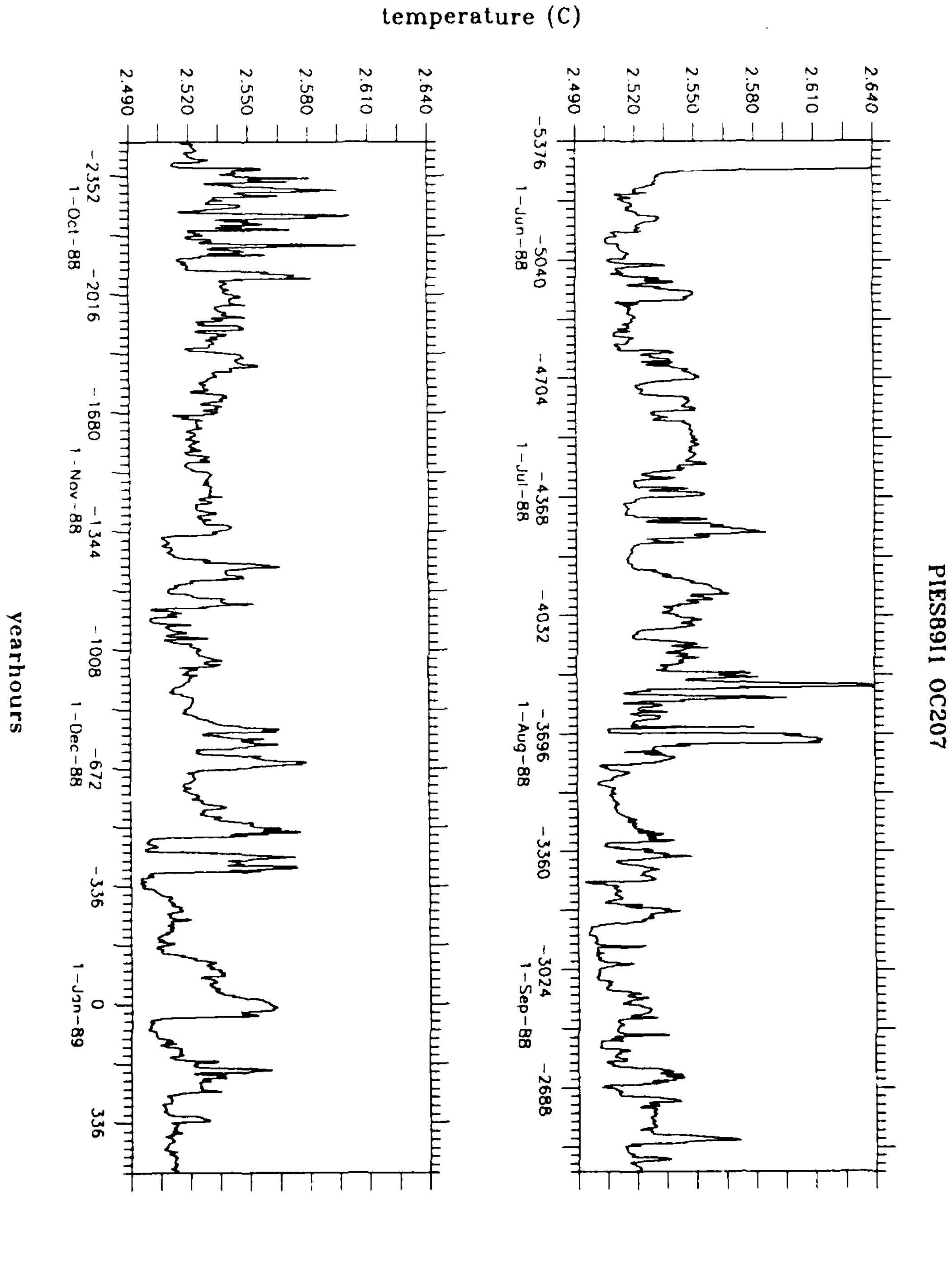
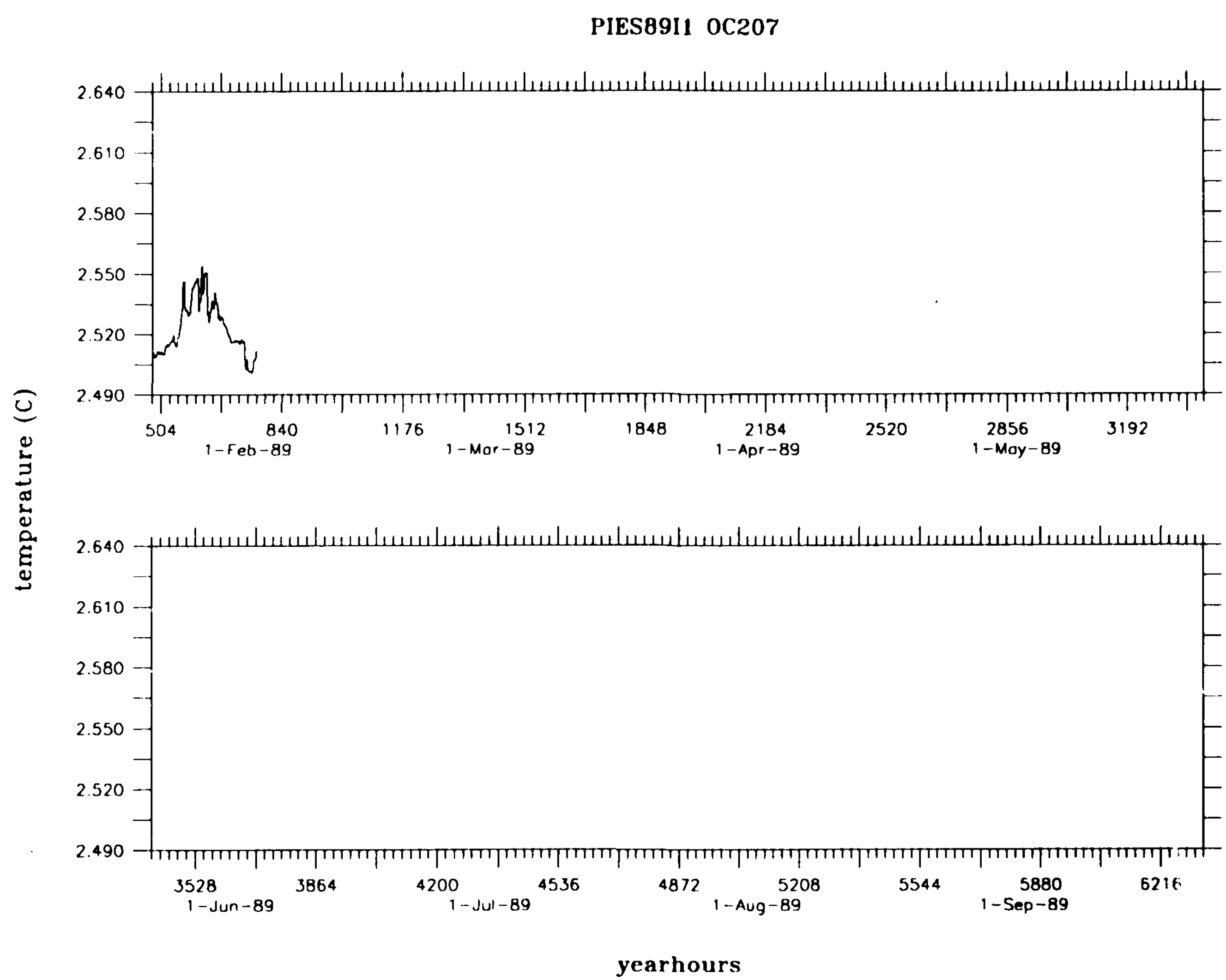


Figure 8.7: Half-Hourly Temperature. PIES89I1_207


PIES89I1 OC207
temperature (C)
2.640
2.610
2.580
2.550
2.520
2.490
504
840
1 -Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

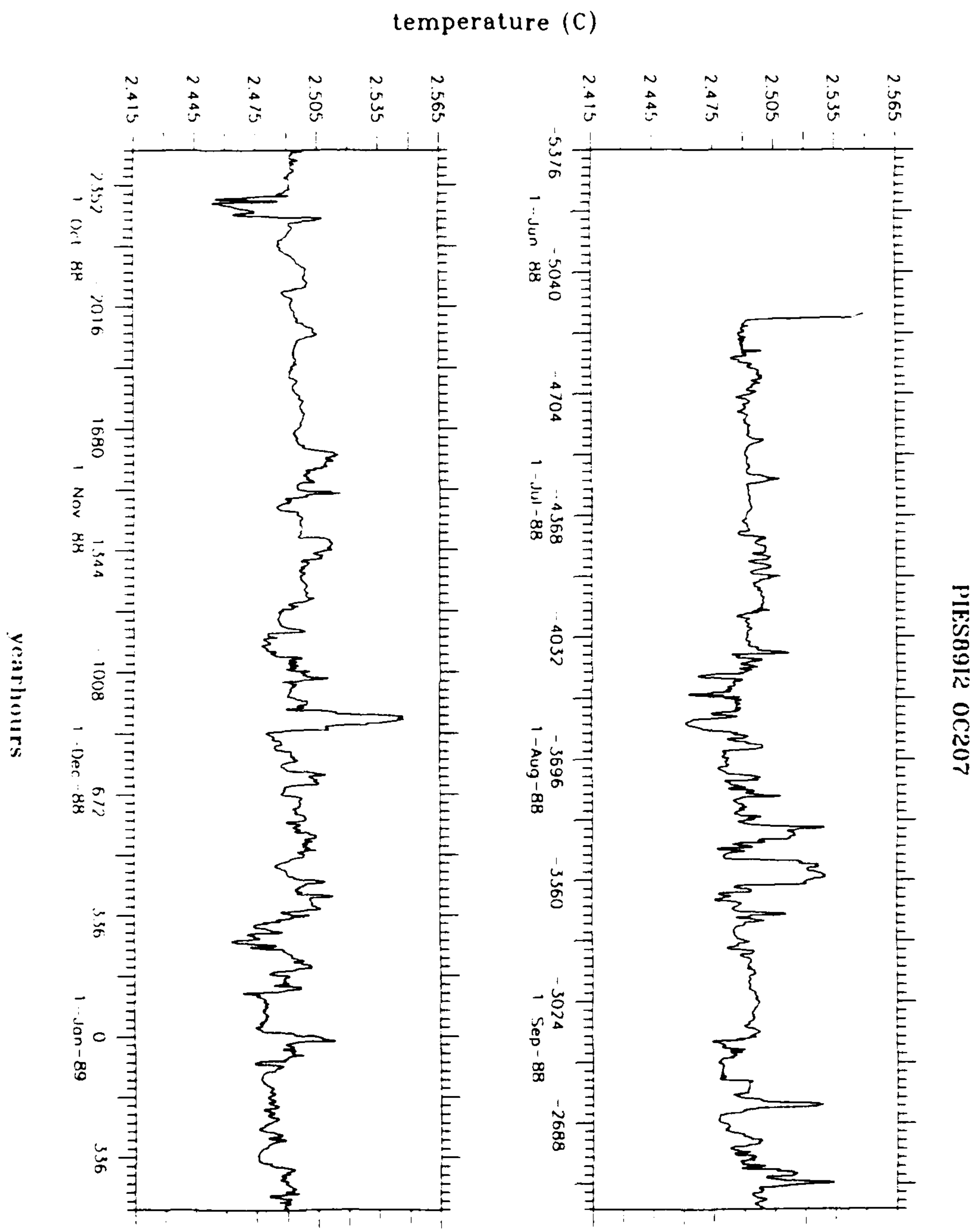
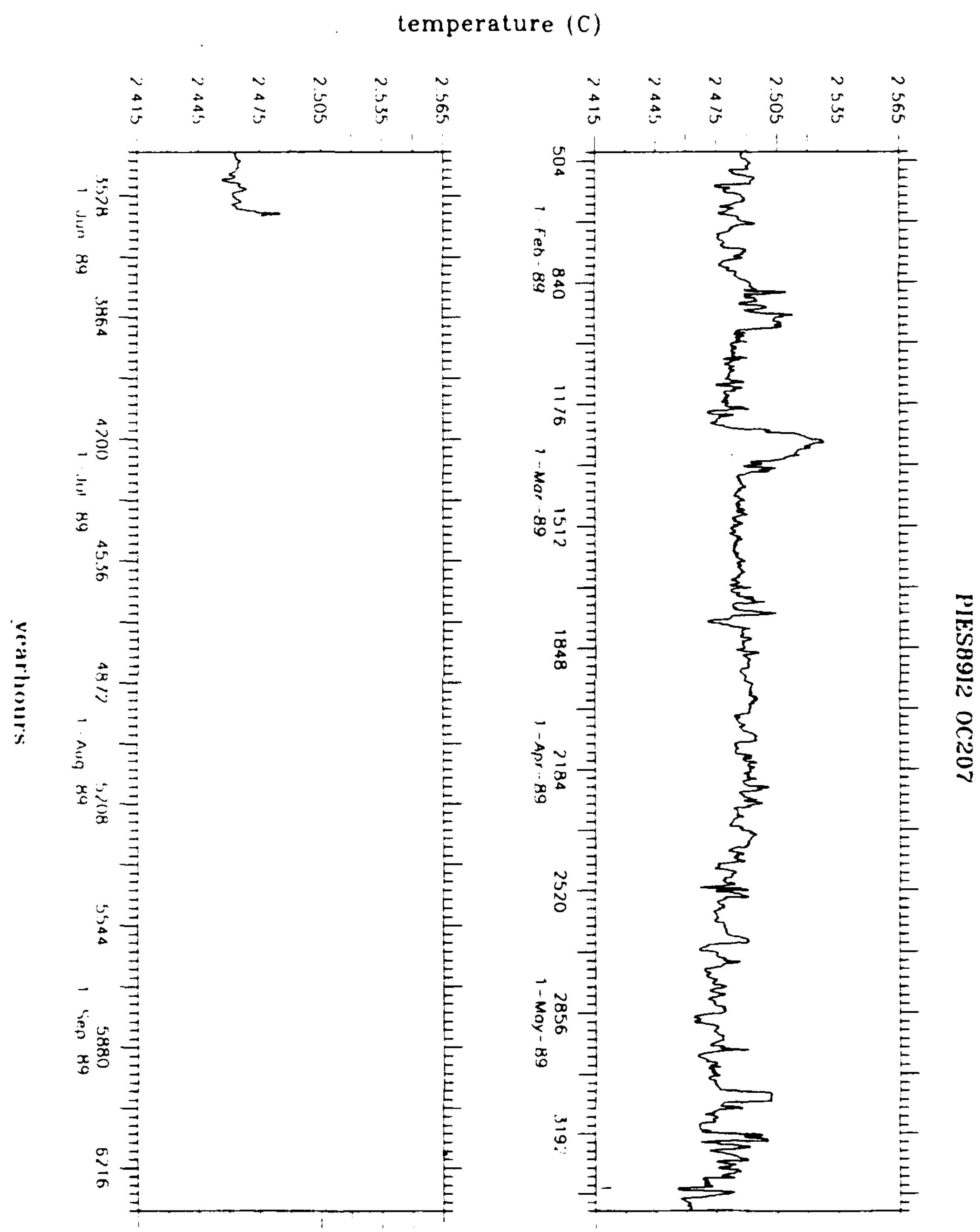


Figure 8.8: Half-Hourly Temperature. PIES89I2_207


PIES8912 OC207
temperature (C)
2.565
2.535
2.505
2.475
2.445
2.415
504
840
1 Feb 89
1176
1512
1 Mar 89
1848
2184
1 Apr 89
2520
2856
1 May 89
3528
1 Jun 89
3864
4200
1 Jul 89
4536
4872
1 Aug 89
5544
5880
1 Sep 89
6216
yearhours

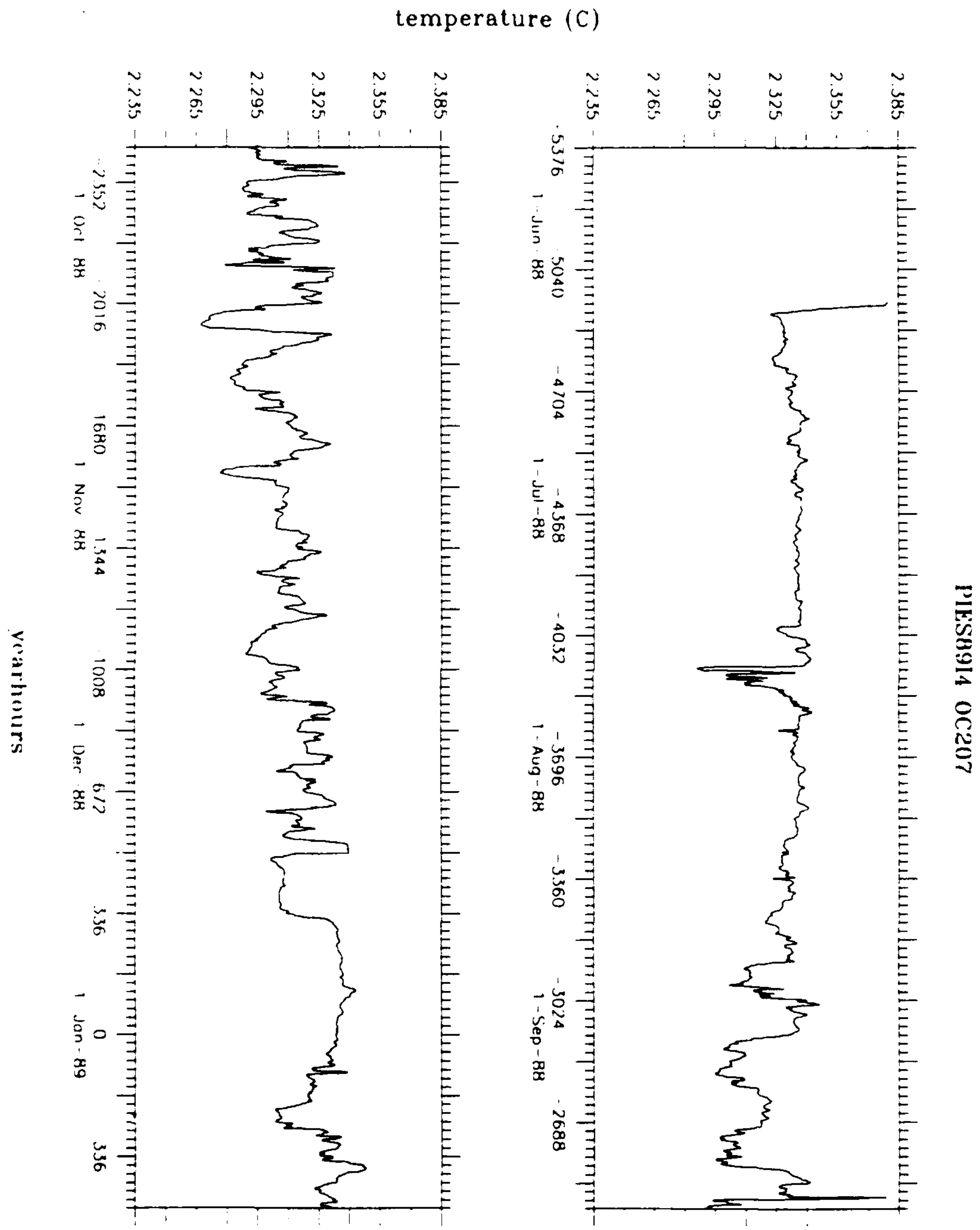
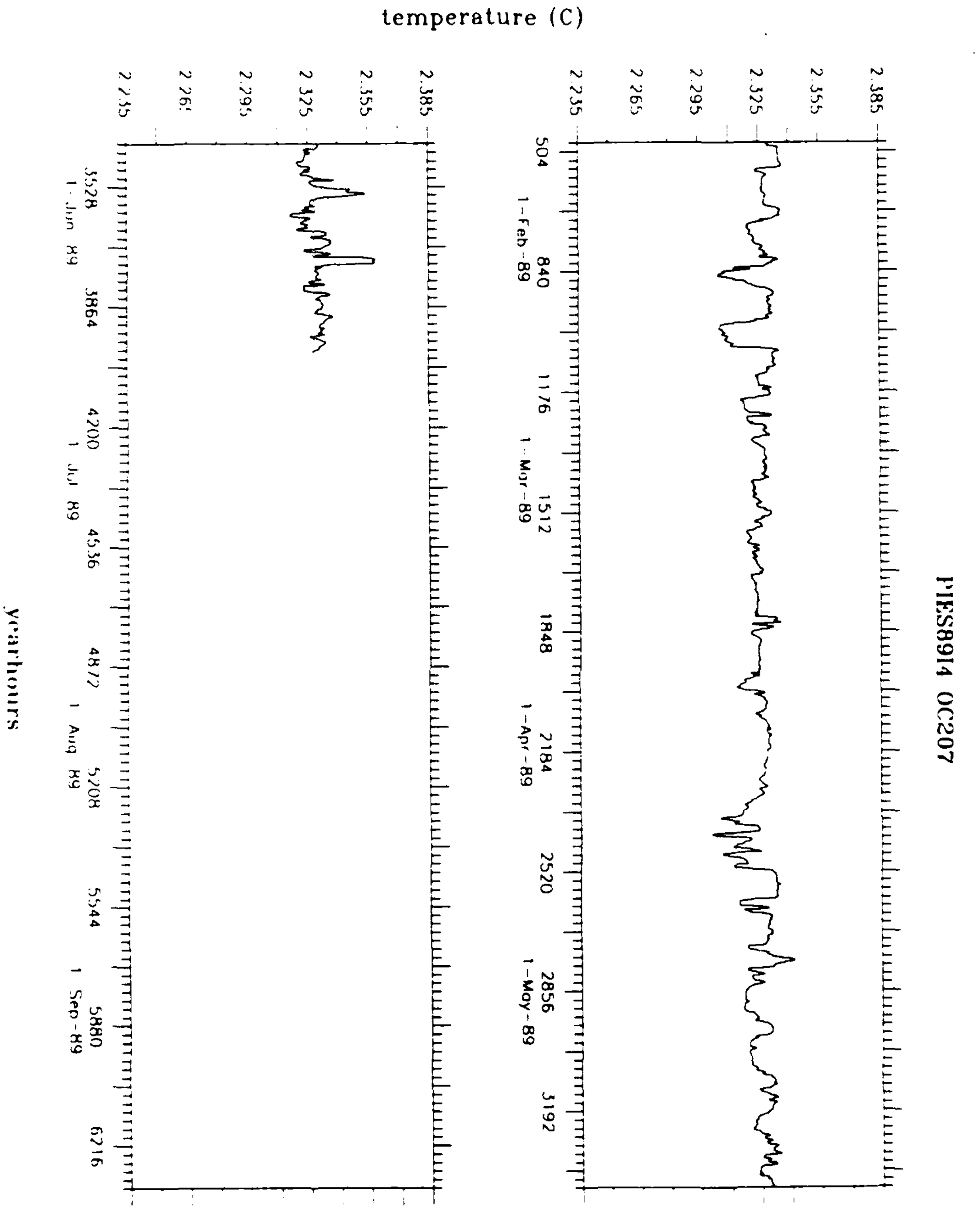


Figure 8.9: Half-Hourly Temperature. PIES8914_207


PIES8914 OC207
temperature (C)
2.385
2.355
2.325
2.295
2.265
2.235
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

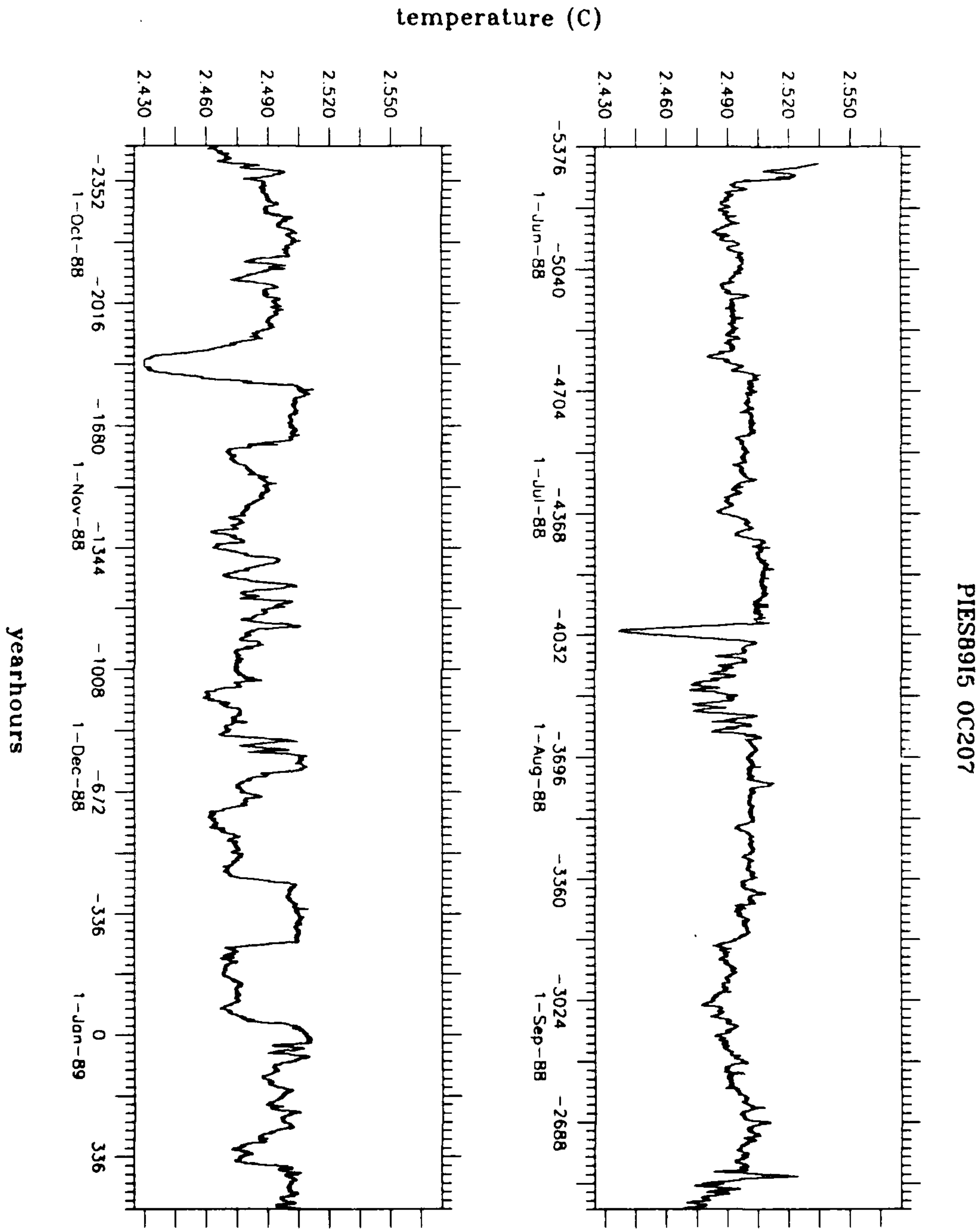
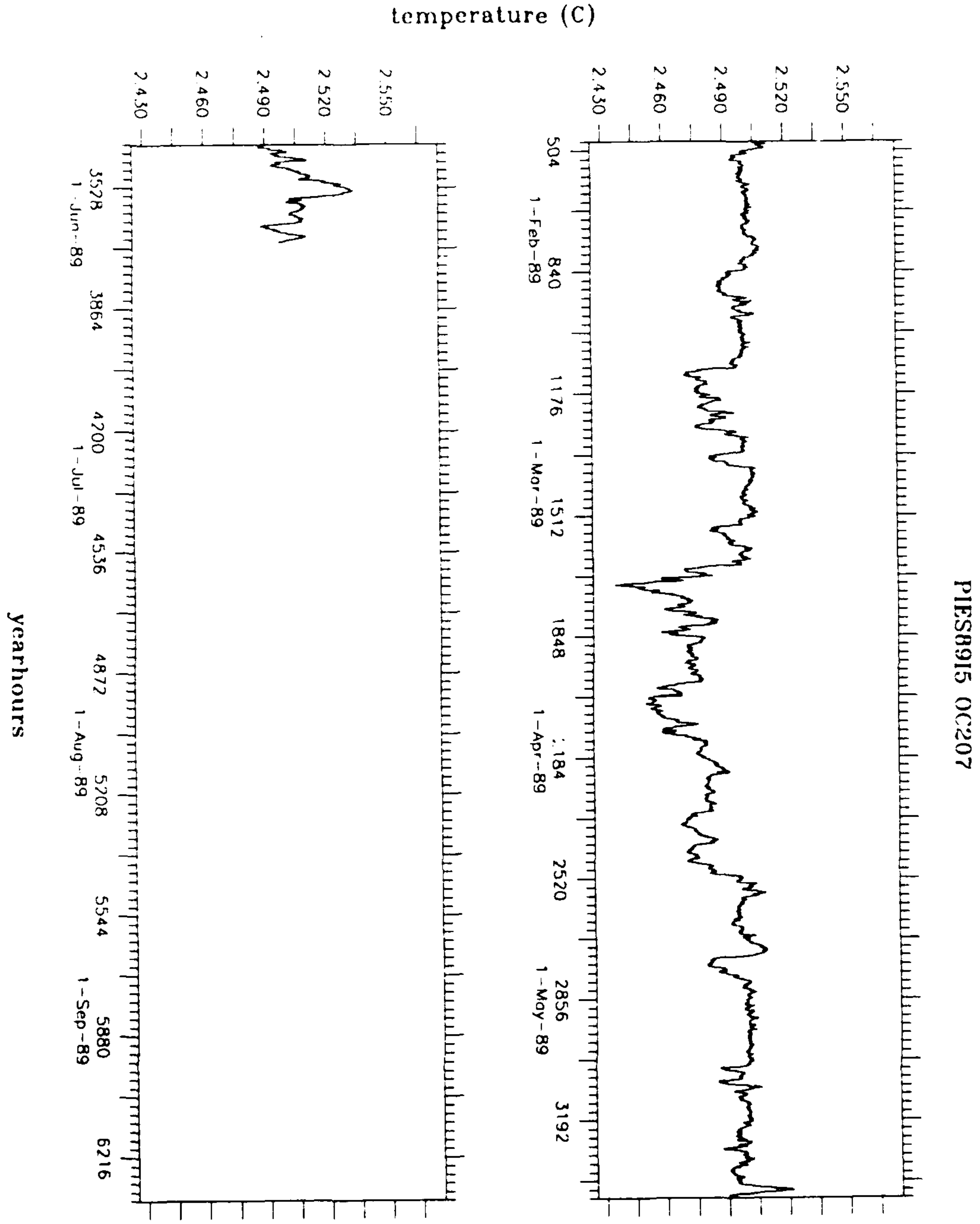


Figure 8.10: Half-Hourly Temperature. PIES89I5_207


PIES8915 OC207
temperature (C)
2.430
2.460
2.490
2.520
2.550
504
840
1-Feb-89
1176
1-Mar-89
1512
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216
yearhours

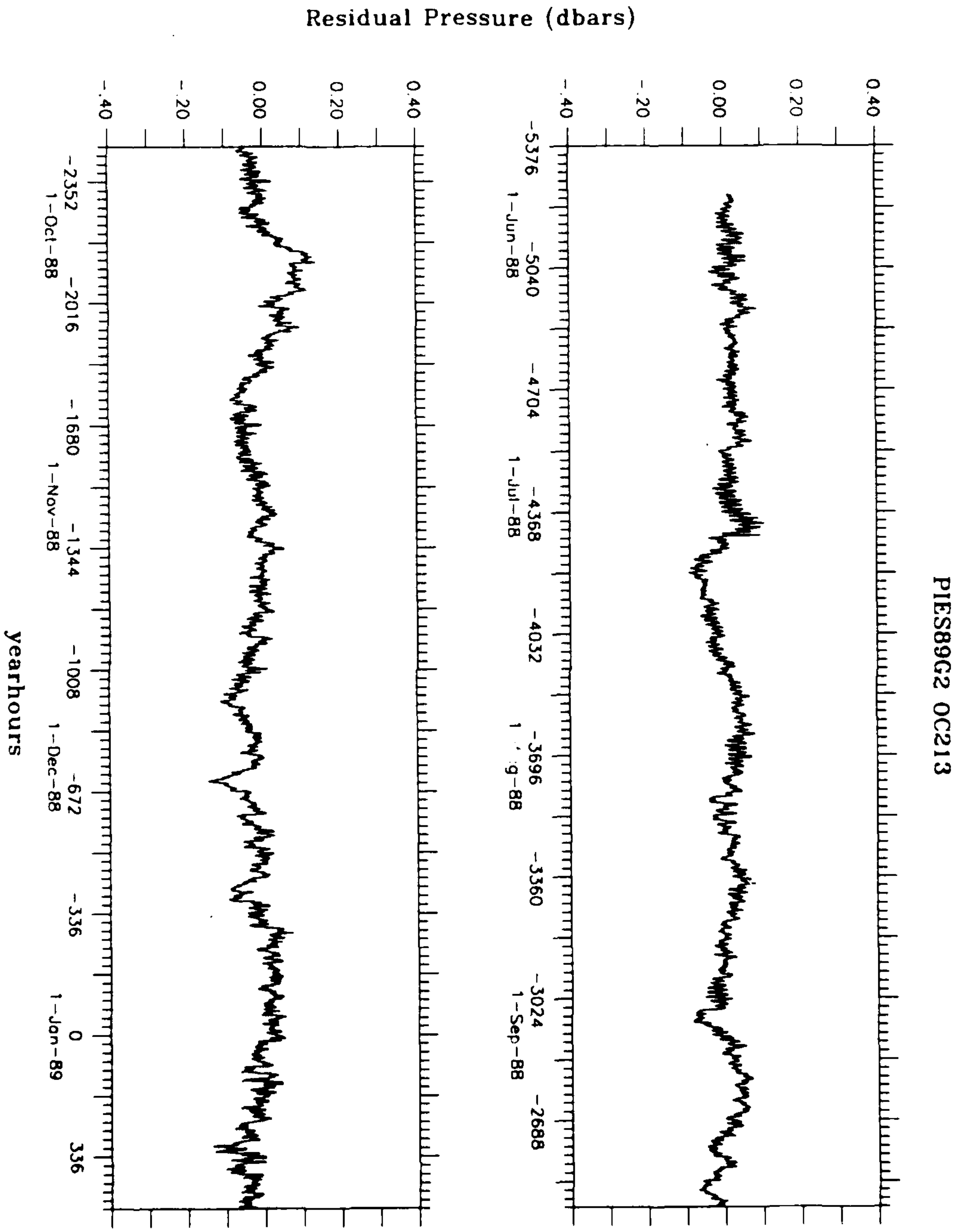
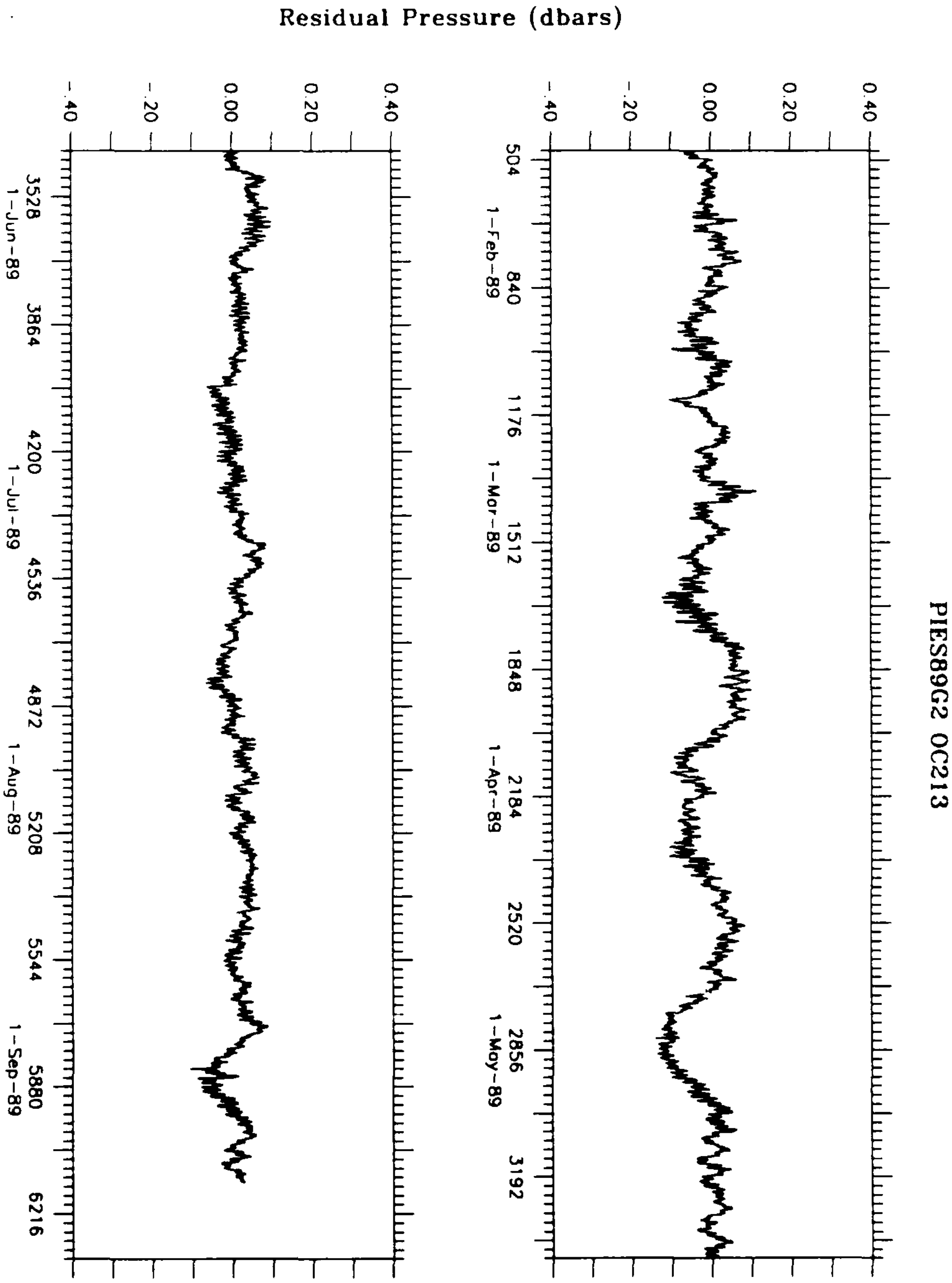


Figure 9.1: Half-Hourly Residual Bottom Pressure. PIES89G2_213


PIES89G2 OC213
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
1-Sep-89
5880
6216

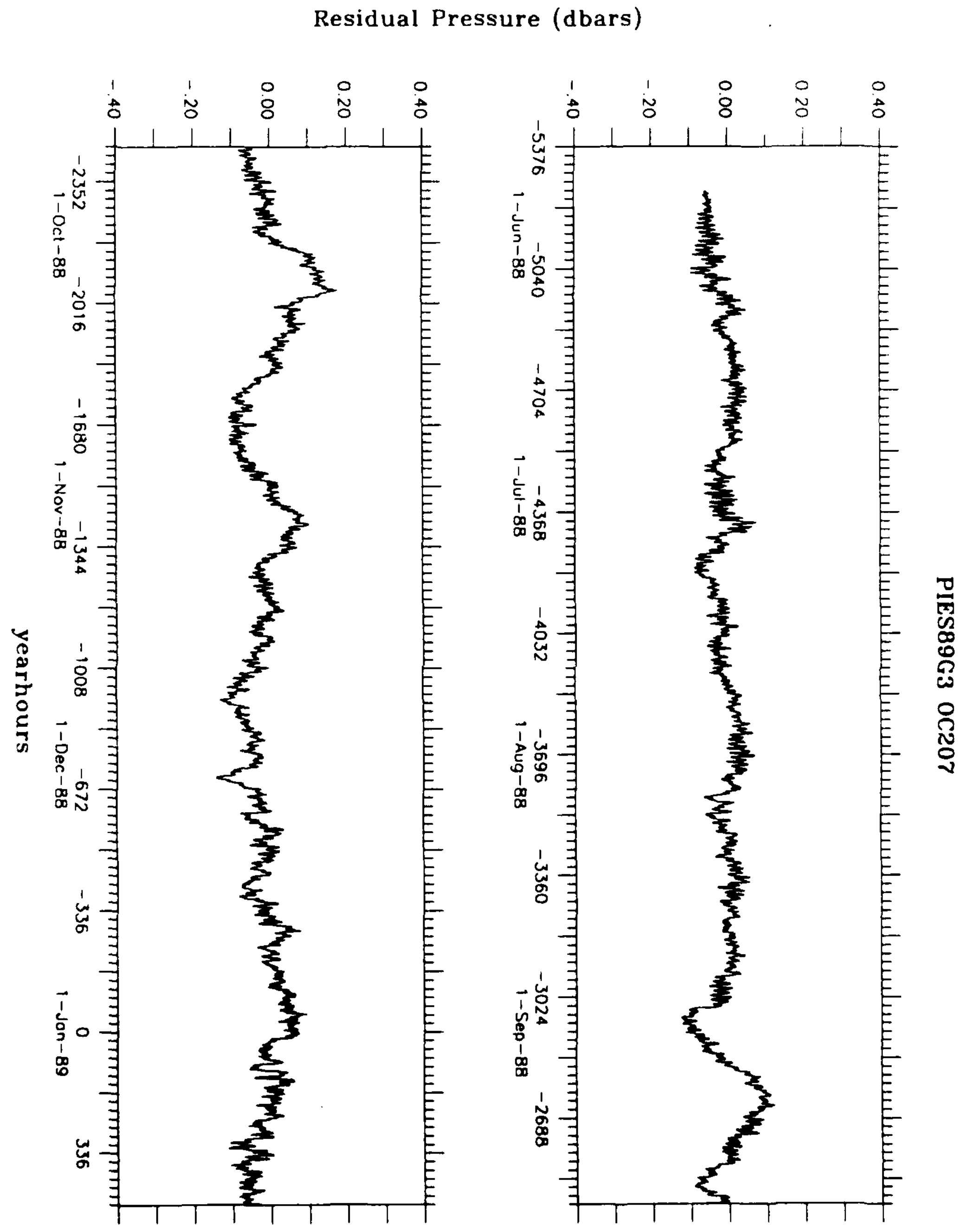
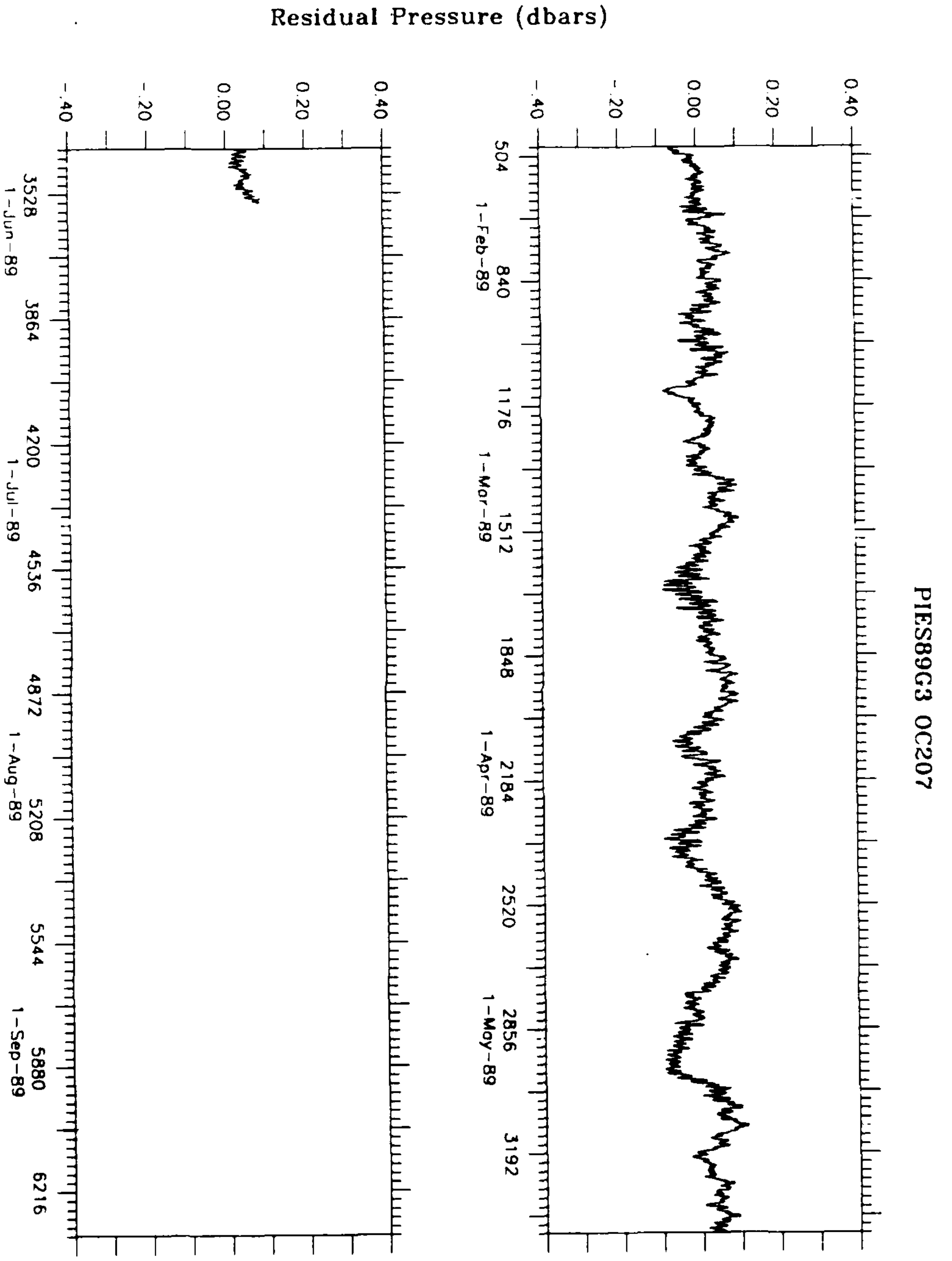


Figure 9.2: Half-Hourly Residual Bottom Pressure. PIES89G3_207


PIES89G3 OC207
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89

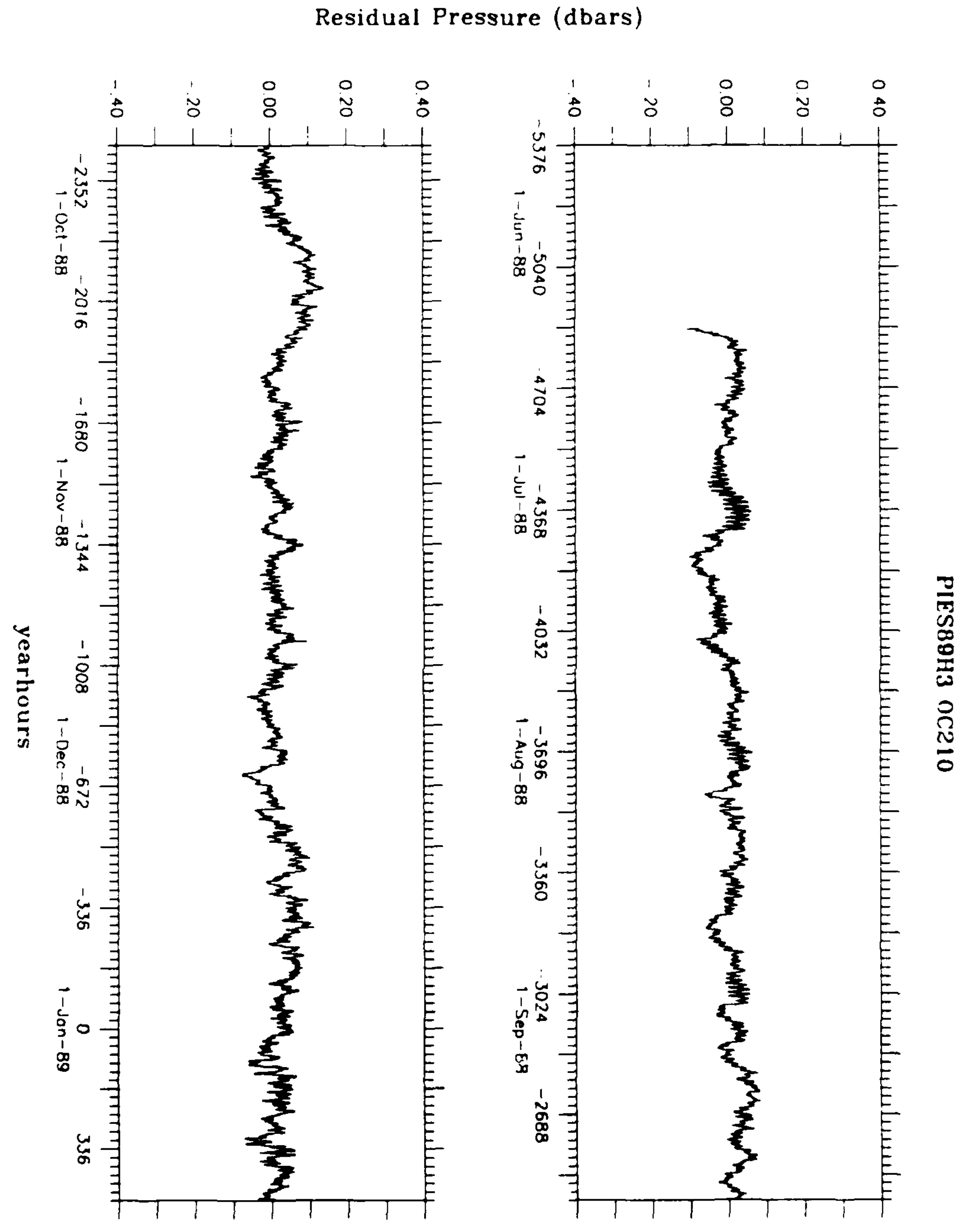
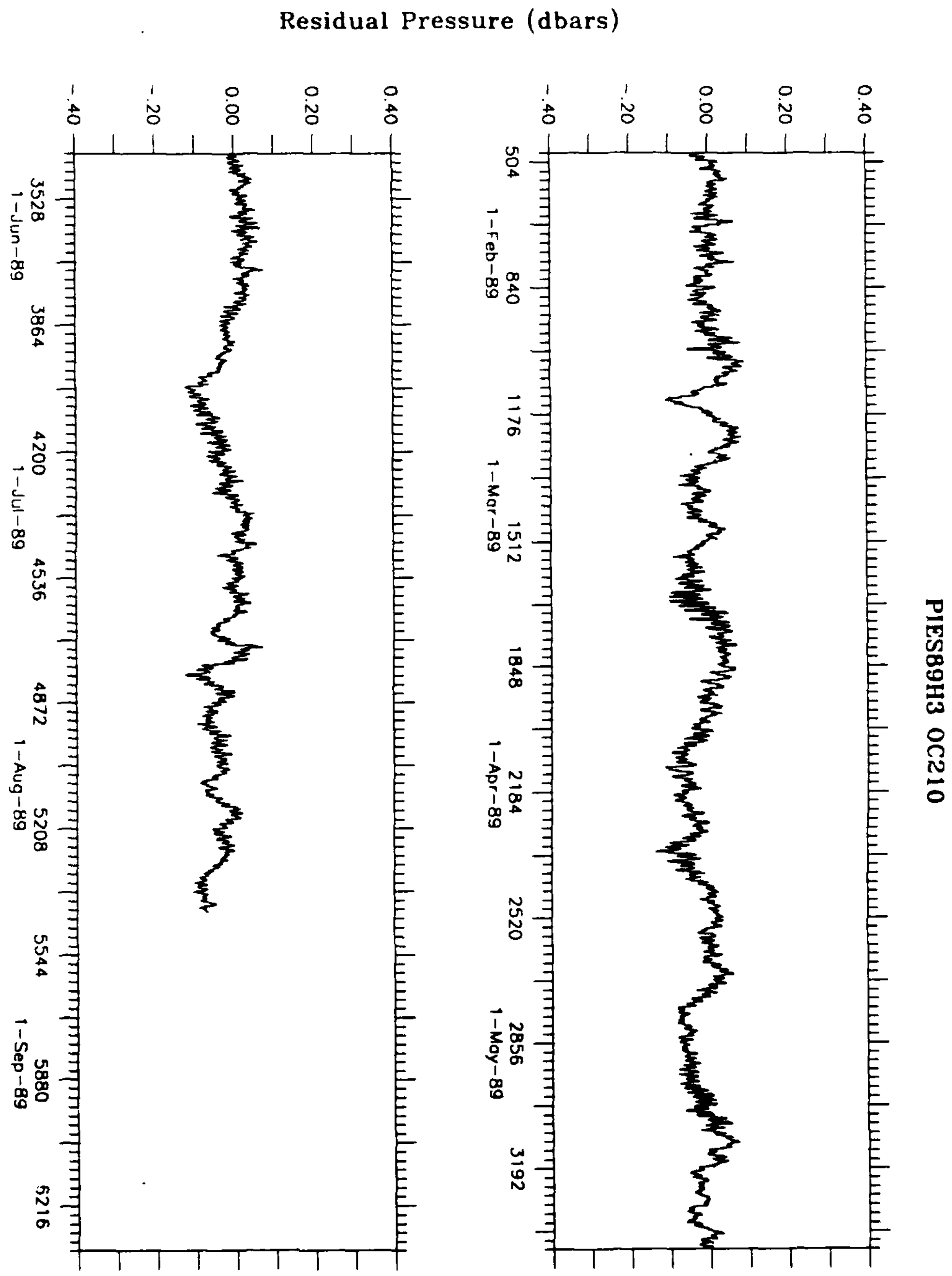


Figure 9.3: Half-Hourly Residual Bottom Pressure. PIES89H3_210


PIES89H3 OC210
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89

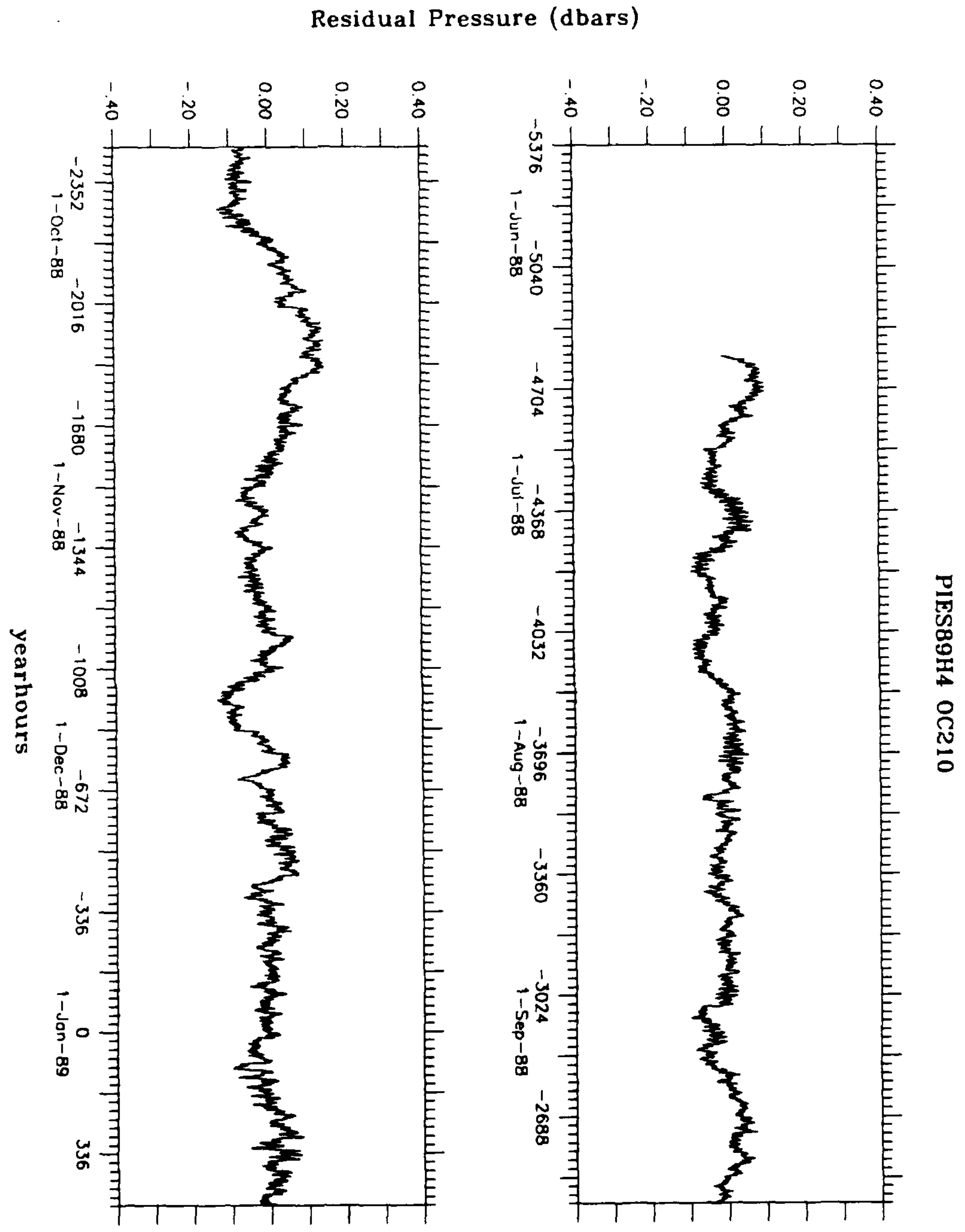
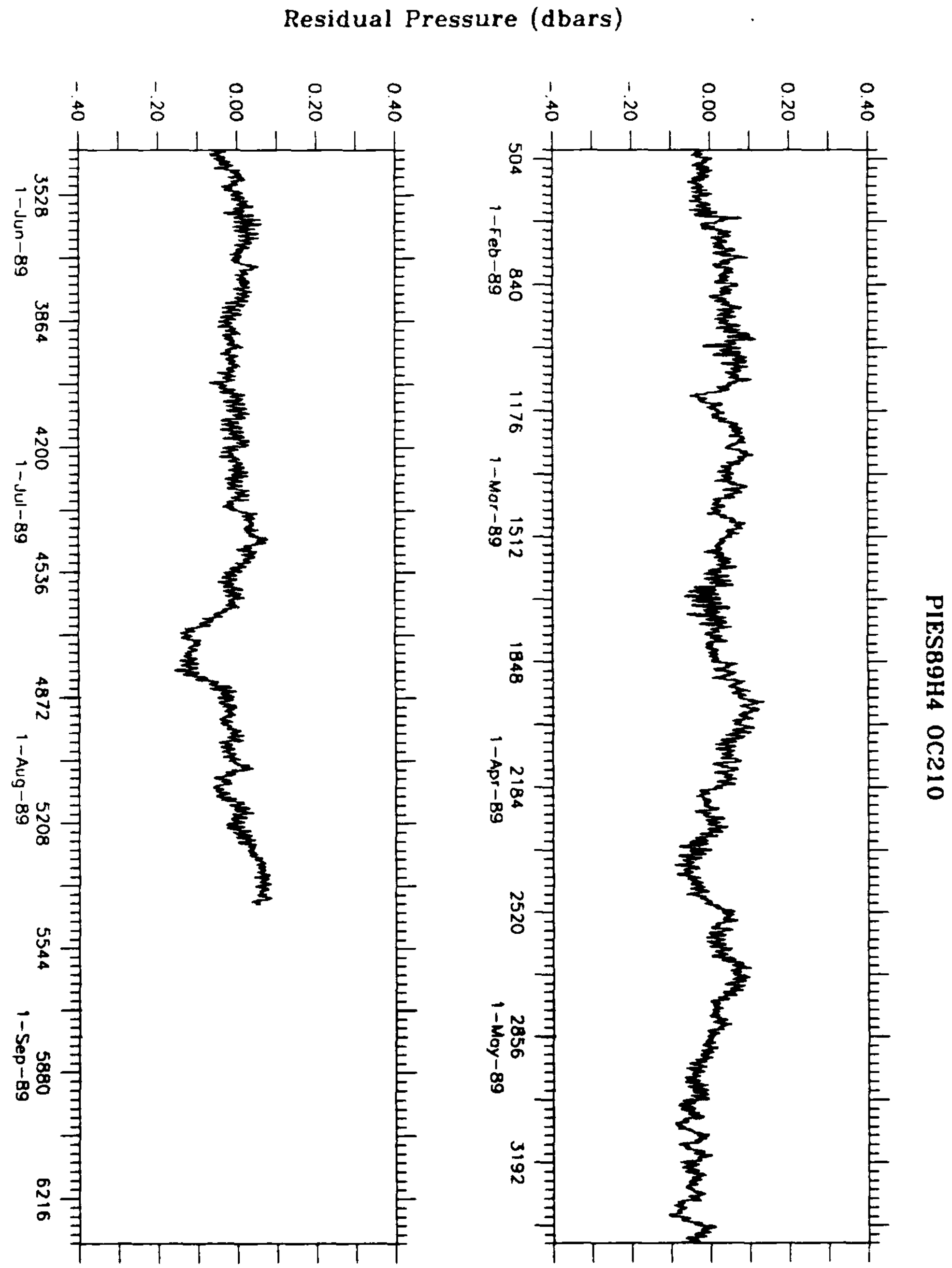


Figure 9.4: Half-Hourly Residual Bottom Pressure. PIES89H4_210


PIES89H4 OC210
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1-Feb-89
1176
1-Mar-89
1512
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216

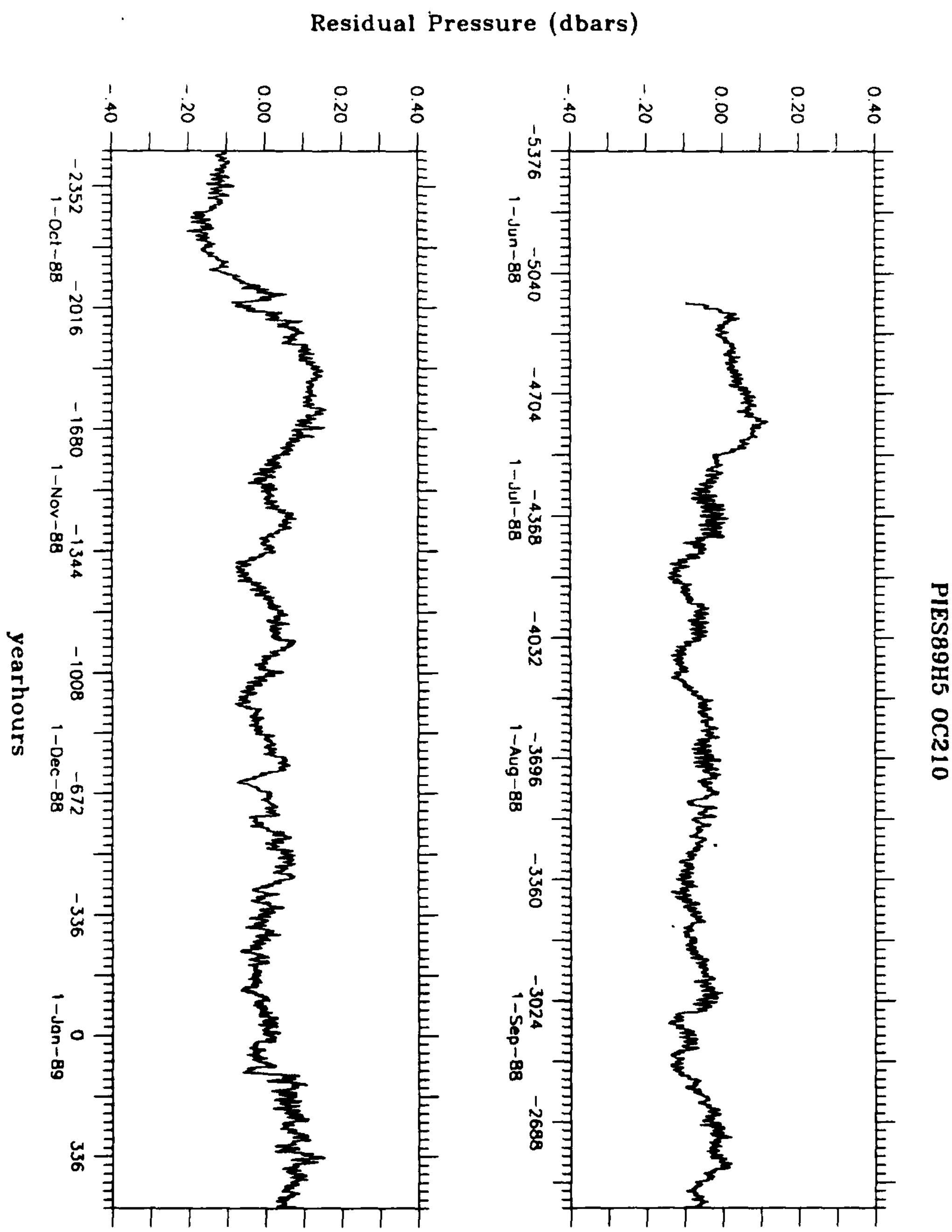
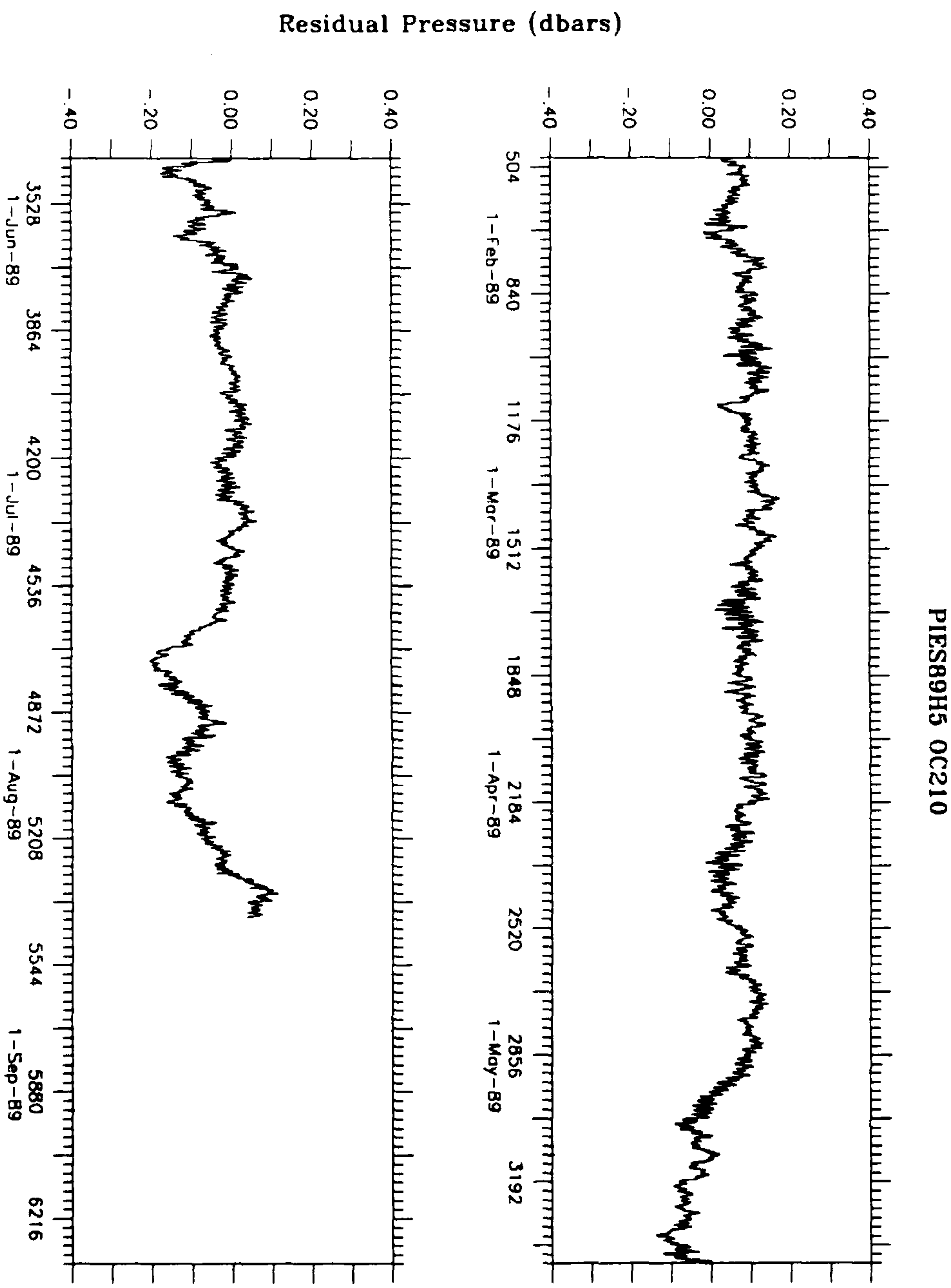


Figure 9.5: Half-Hourly Residual Bottom Pressure. PIES89H5_210


PIES89H5 OC210
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216

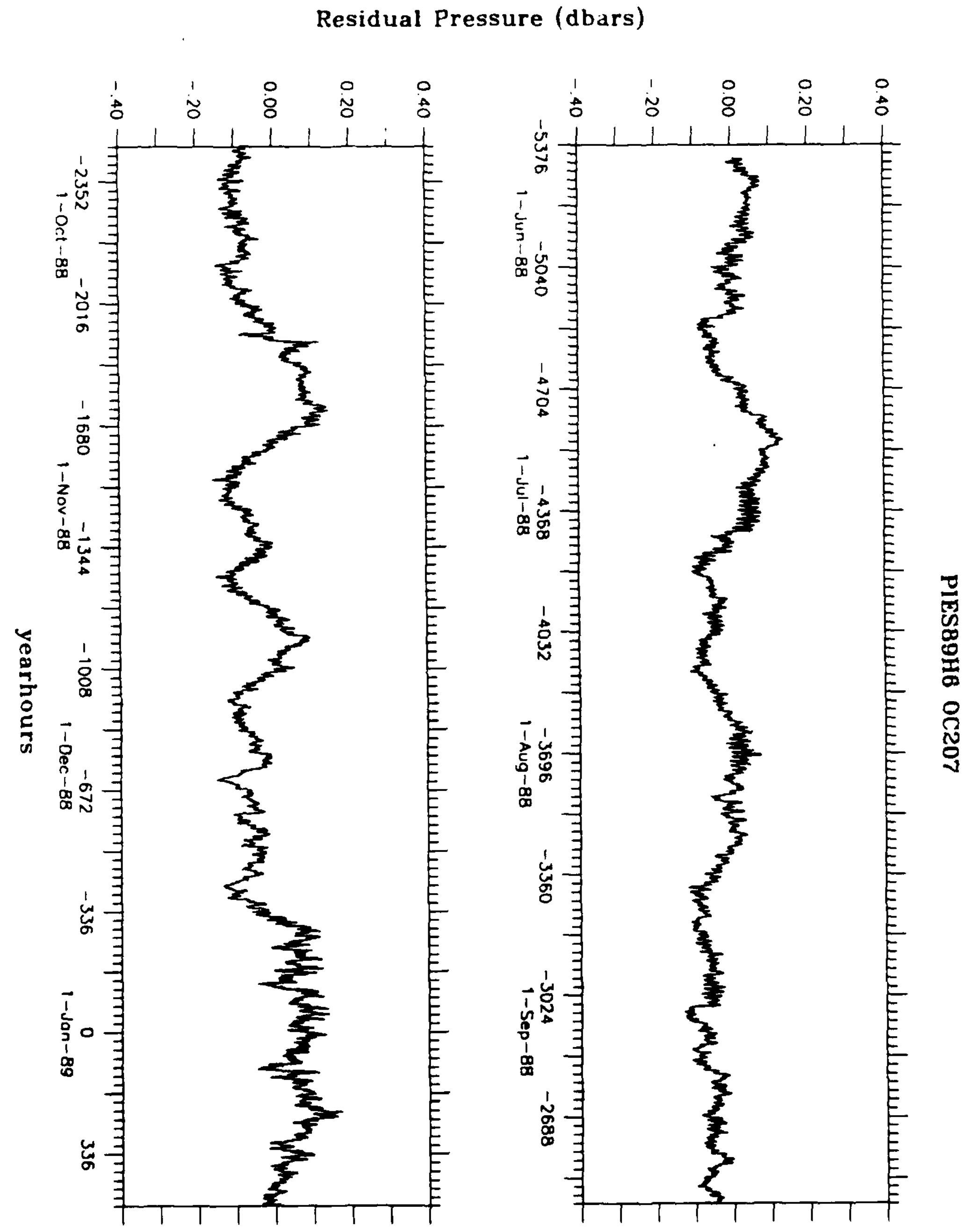
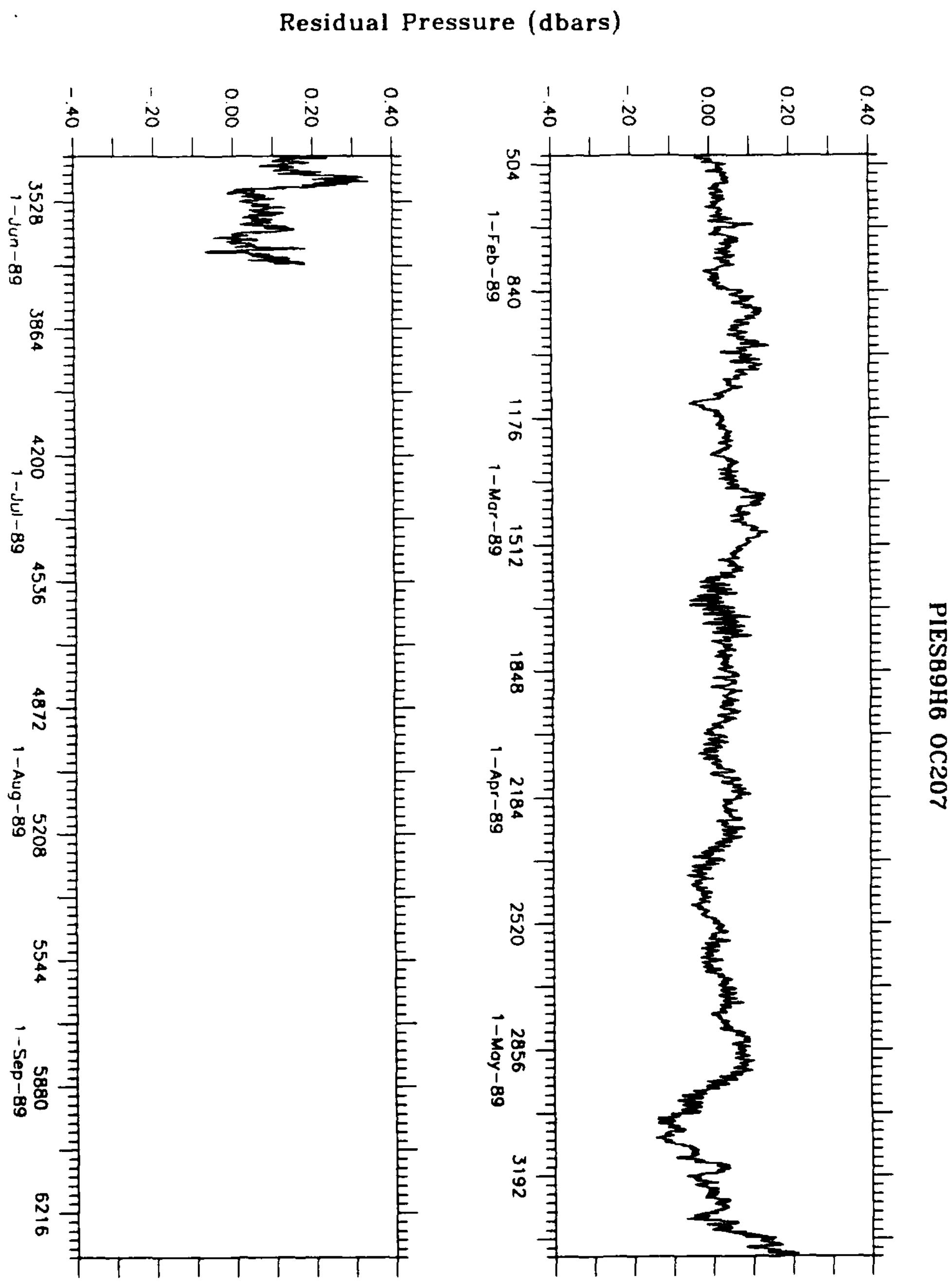


Figure 9.6: Half-Hourly Residual Bottom Pressure. PIES89H6_207


PIES89H6 OC207
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1-Feb-89
1176
1-Mar-89
1512
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216

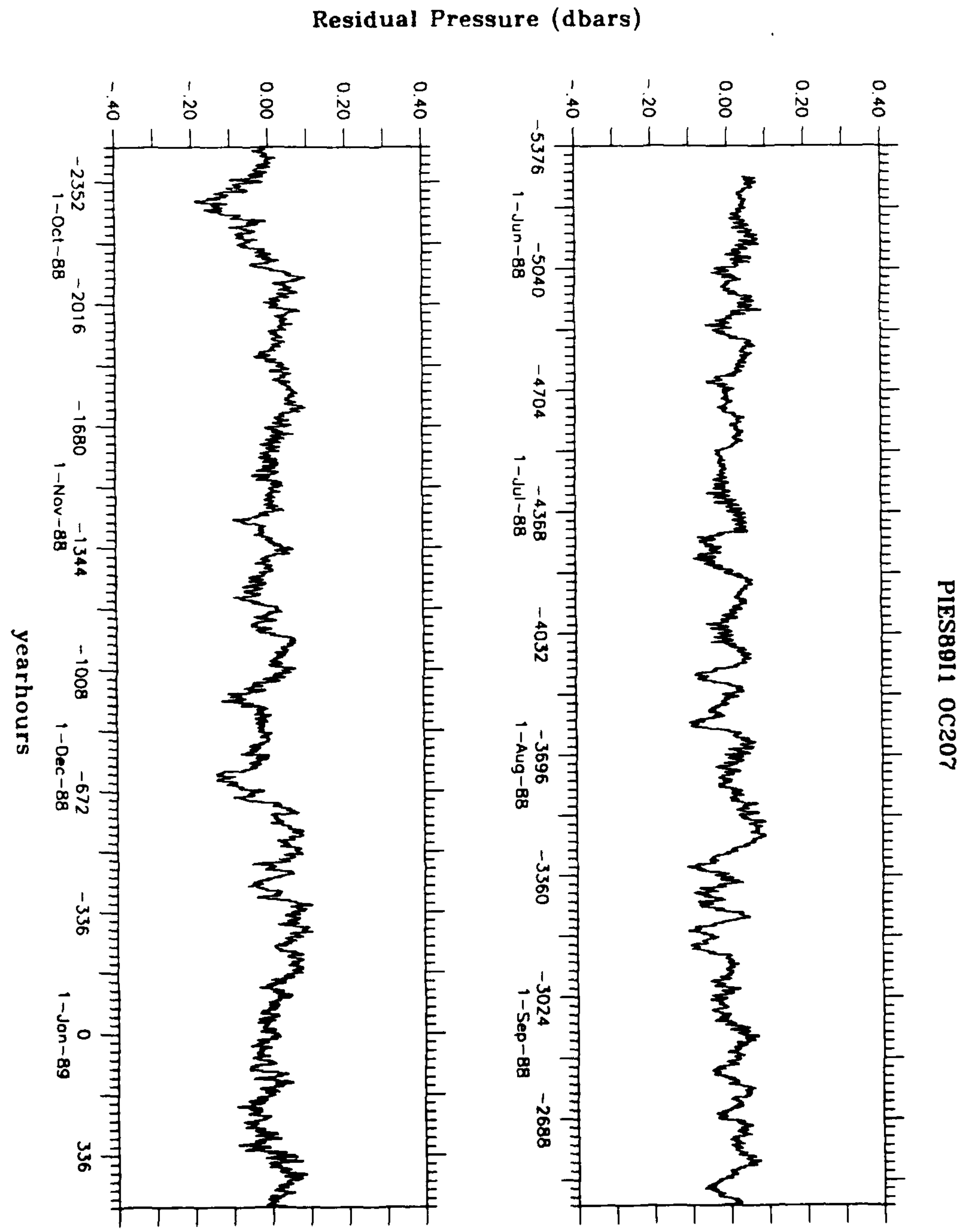
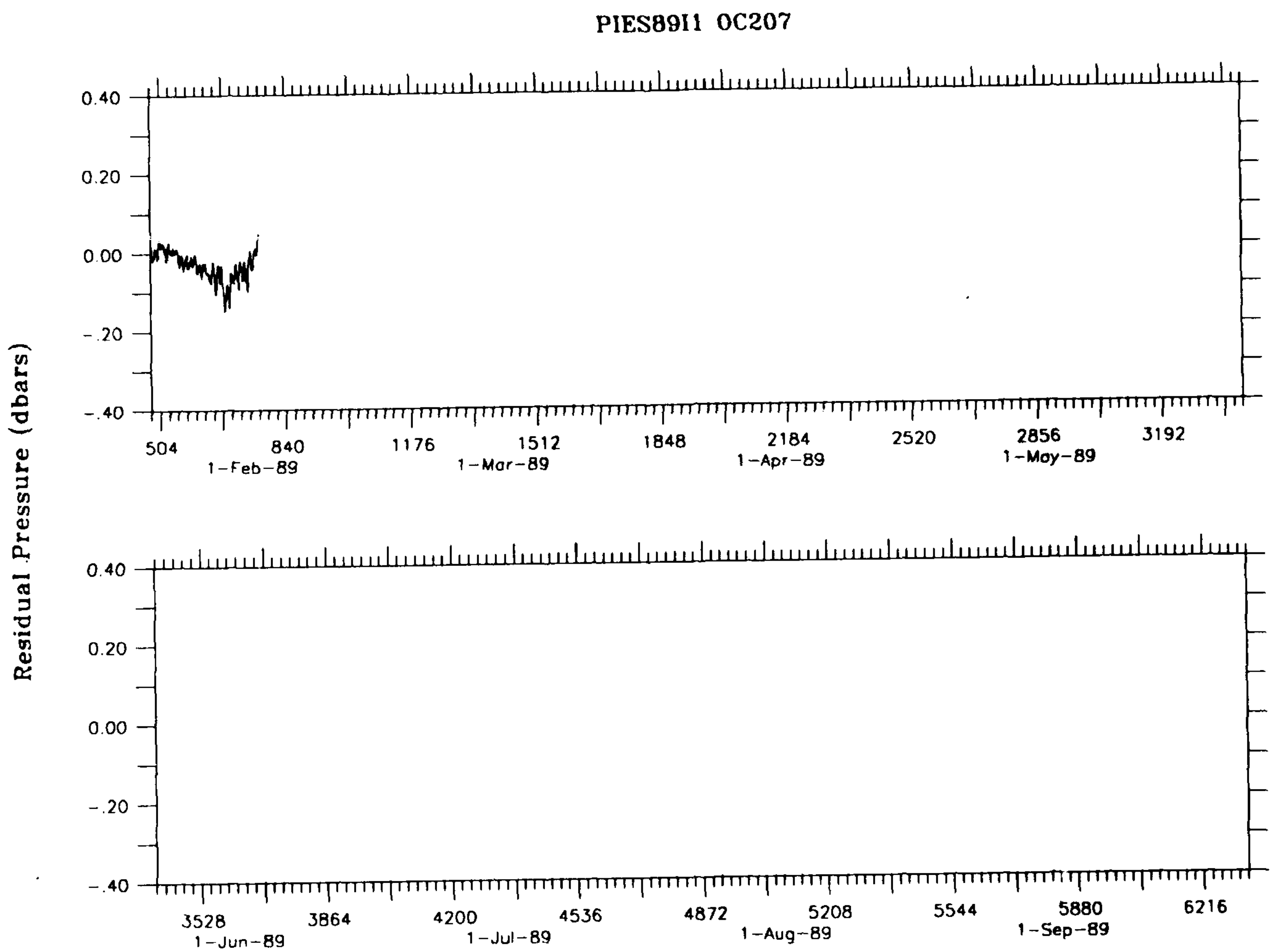


Figure 9.7: Half-Hourly Residual Bottom Pressure. PIES89I1_207


PIES89I1 OC207
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
0.40
0.20
0.00
-.20
-.40
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
5208
1-Aug-89
5544
5880
1-Sep-89
6216

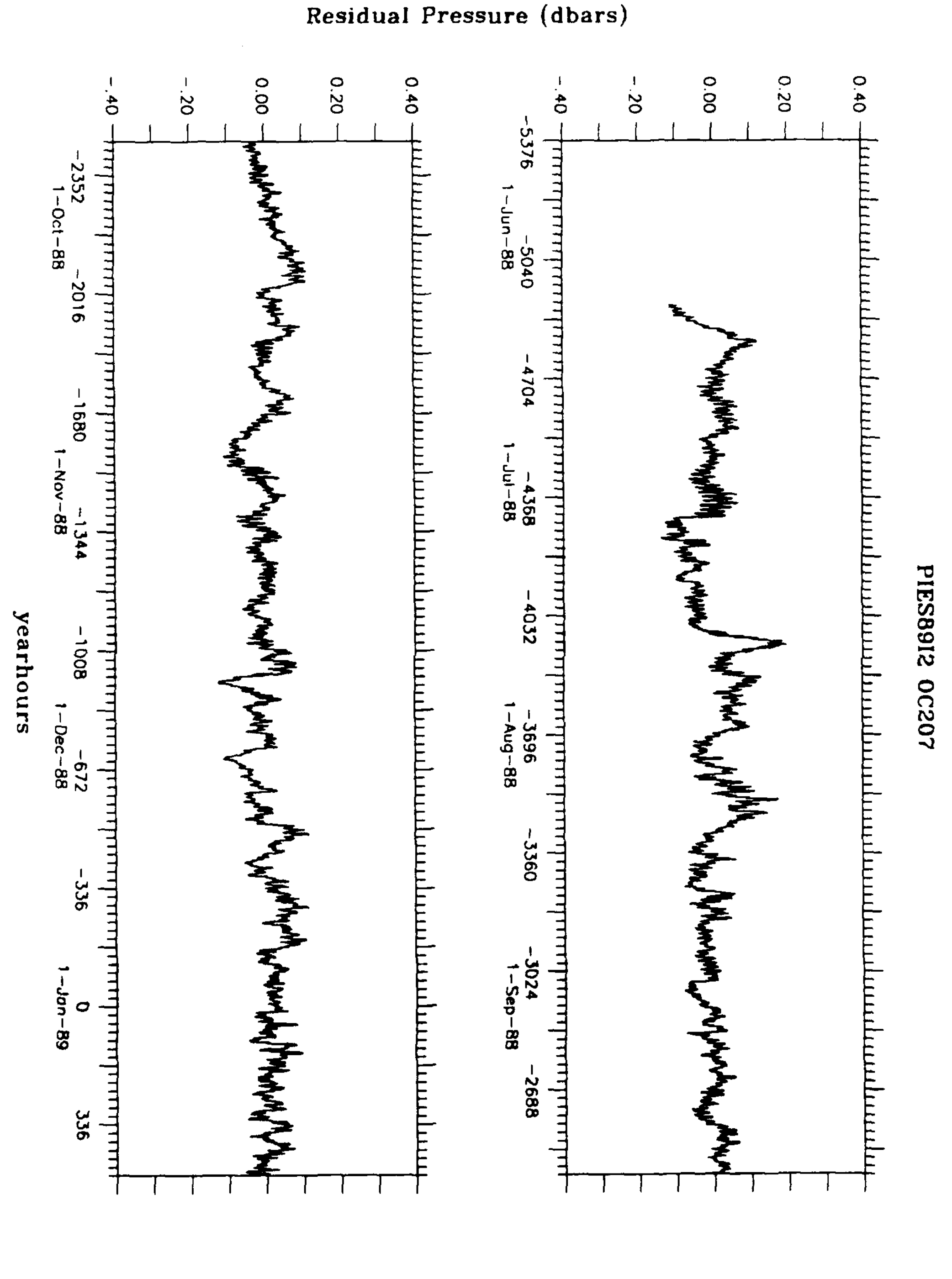
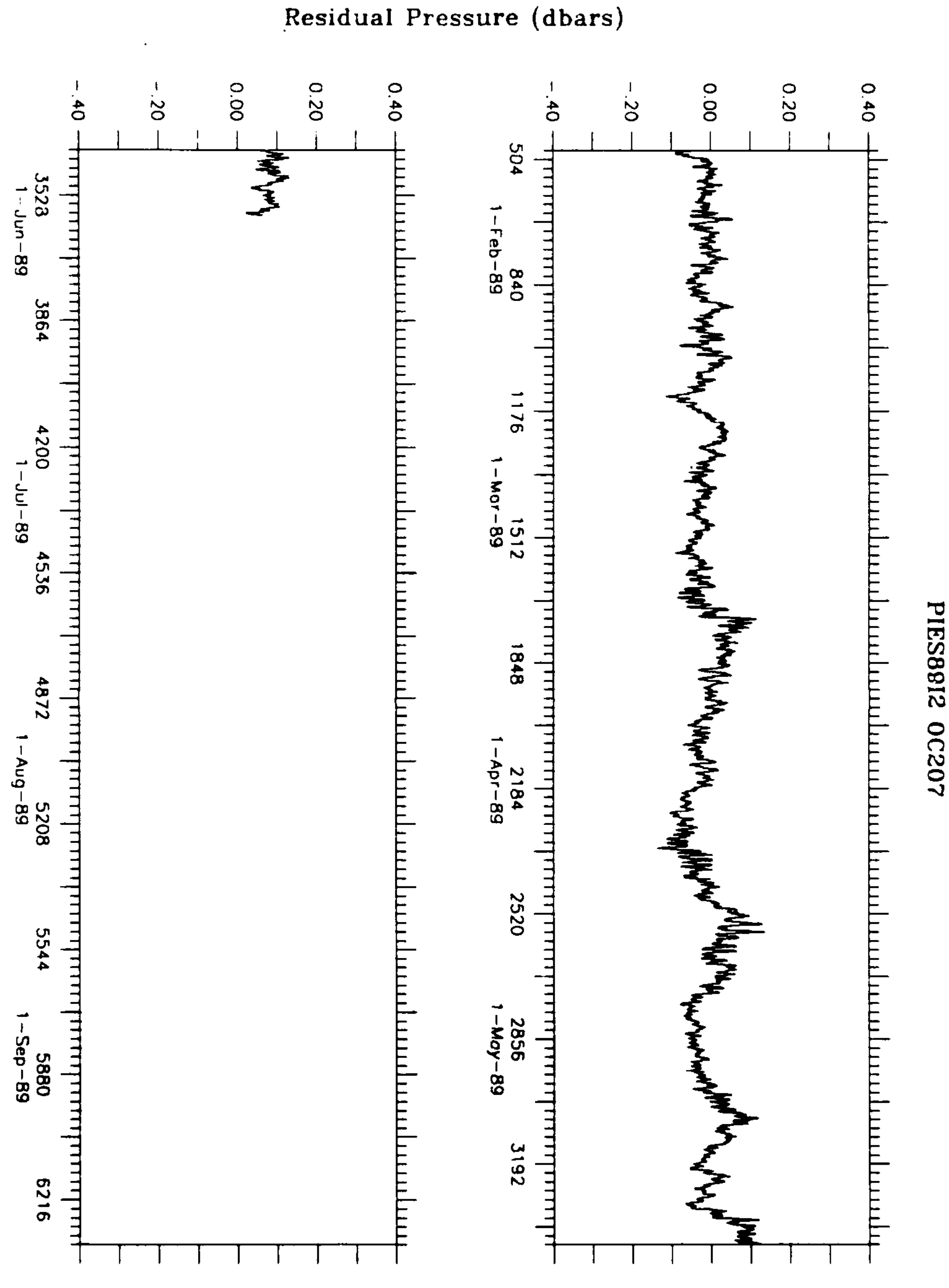


Figure 9.8: Half-Hourly Residual Bottom Pressure. PIES89I2_207


PIES88I2 OC207
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-89
1-Mar-89
1-Apr-89
1-May-89
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-89
1-Jul-89
1-Aug-89
1-Sep-89

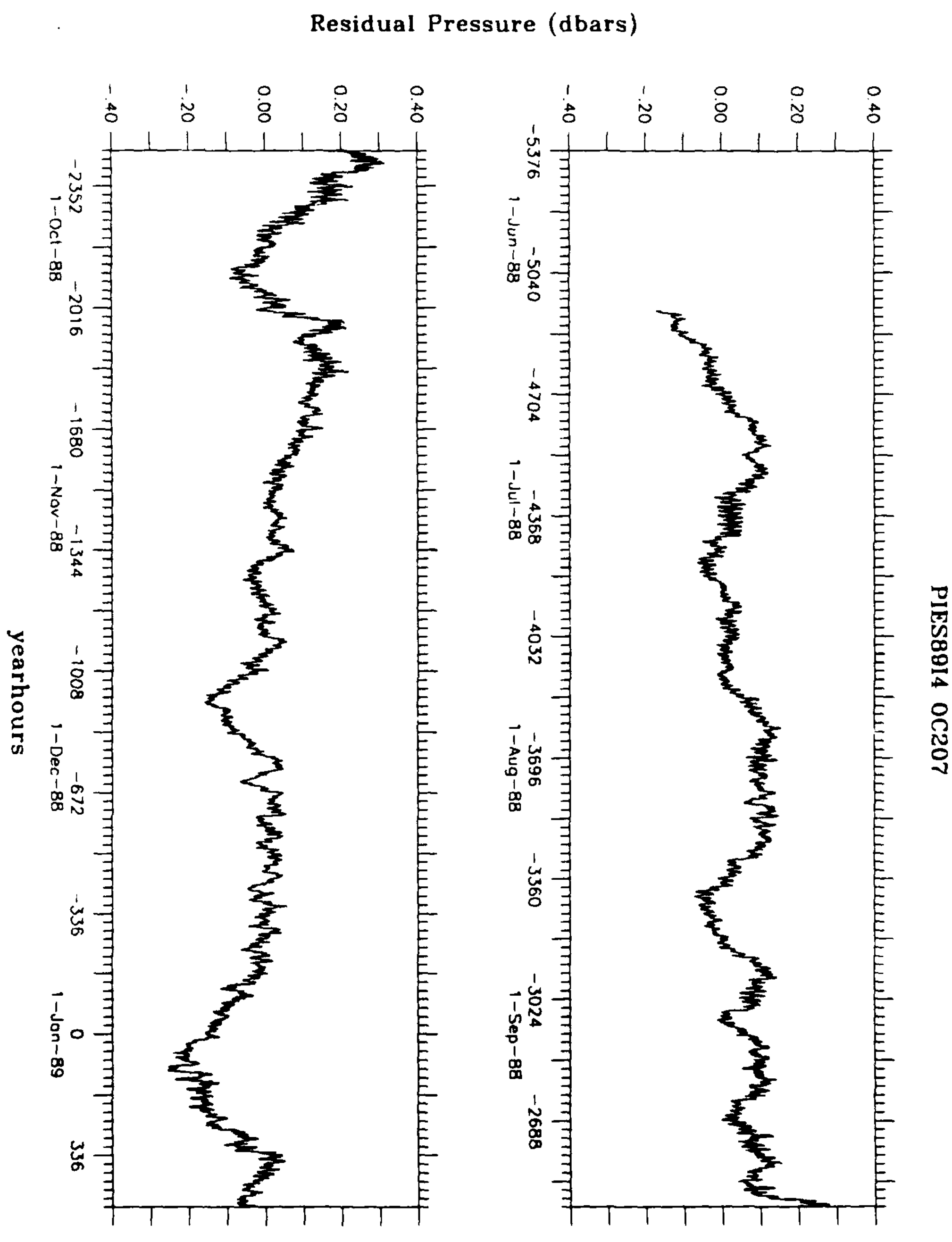
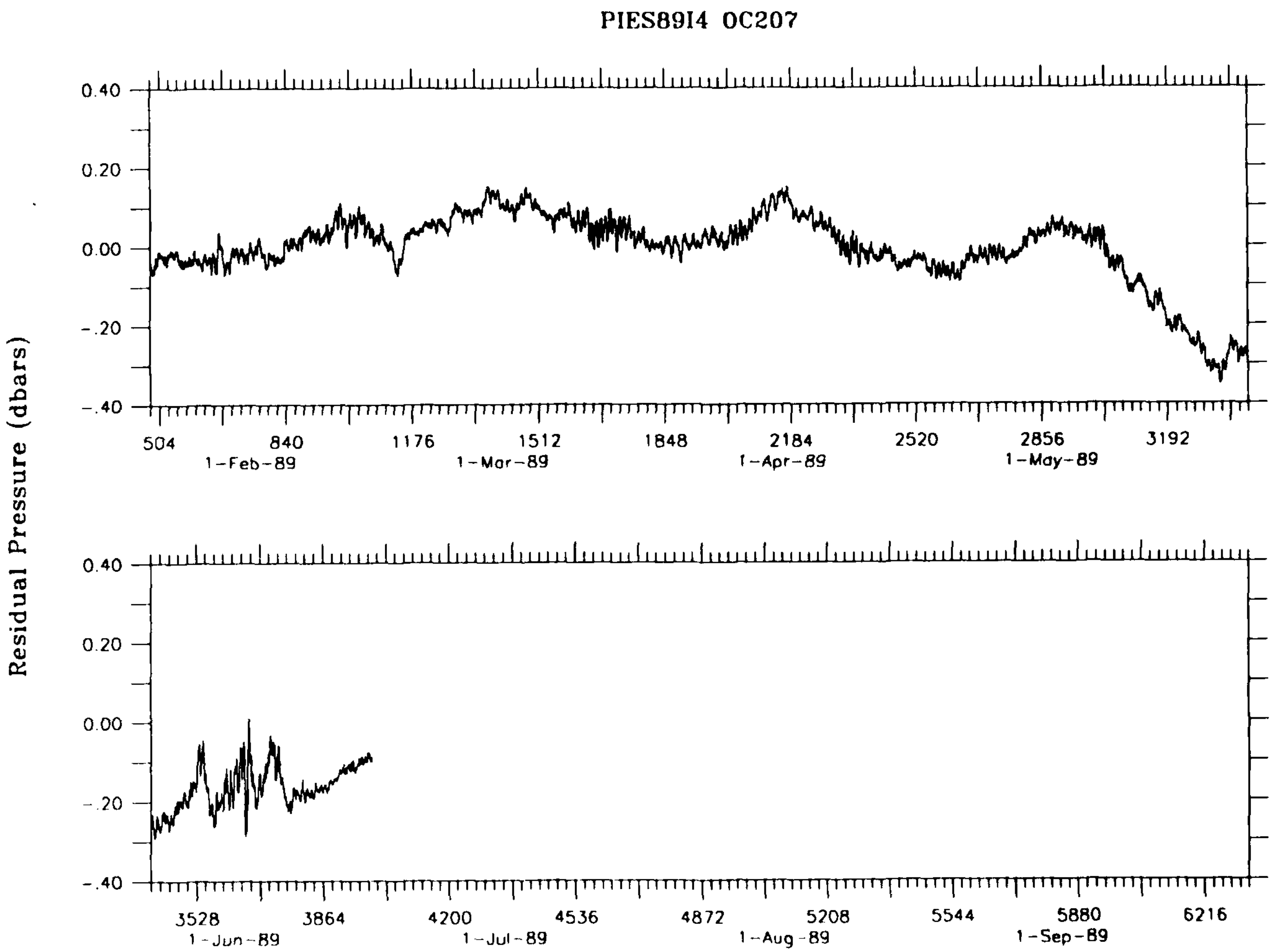


Figure 9.9: Half-Hourly Residual Bottom Pressure. PIES89I4_207


PIES89I4 OC207
Residual Pressure (dbars)
0.40
0.20
0.00
-.20
-.40
504
840
1-Feb-89
1176
1512
1-Mar-89
1848
2184
1-Apr-89
2520
2856
1-May-89
3192
3528
1-Jun-89
3864
4200
1-Jul-89
4536
4872
1-Aug-89
5208
5544
5880
1-Sep-89
6216

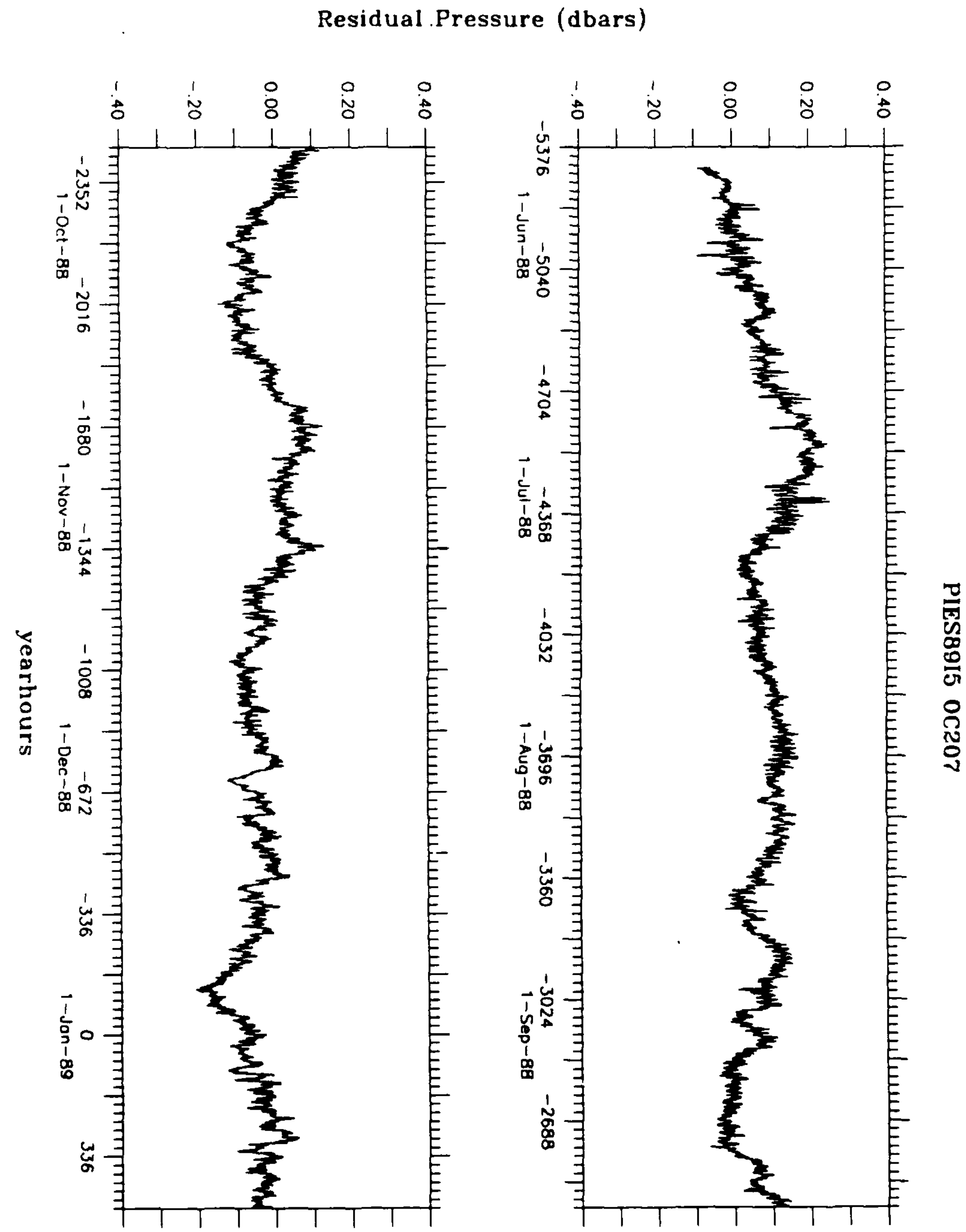
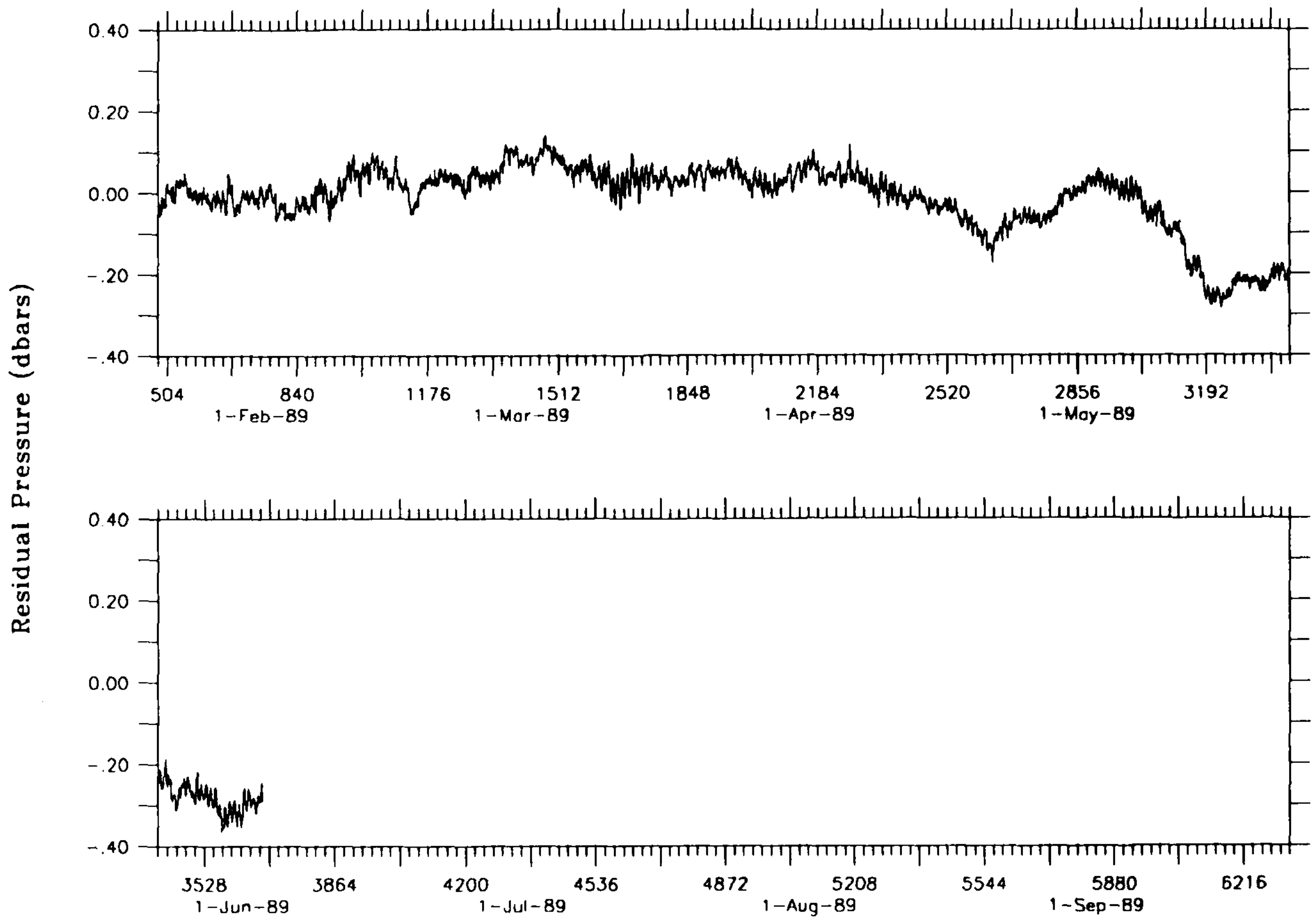


Figure 9.10: Half-Hourly Residual Bottom Pressure. PIES89I5_207

PIES8915 OC207



4 Half-Hourly Line Plots

Travel time, residual bottom pressure, and temperature are plotted, grouped according to instrument–line, B,...J. Line plots display all records in a given line on a single page (except line h which was presented on two pages). All line plots have a time axis running from -6000 hr to 7000 hr in increments of 1000 hr. As with the individual plots, labels associating calendar dates with yearhours are centered beneath the appropriate location.

The vertical axes for each instrument in the line should be the same as those used in the individual plots (section 3). For a given record (travel time, temperature, or pressure) the vertical axis will be consistent for all instruments.

The individual records that compose the line plots are labeled with the site at the right (at yearhour=6500, and centered within the record's vertical axis). It should also be noted that the records of travel time of H7_207 and H7_210 were merged, plotted together in the same panel rather than apart. B4_207 and B4_210; and B5_207 and B5_210 were treated similarly.

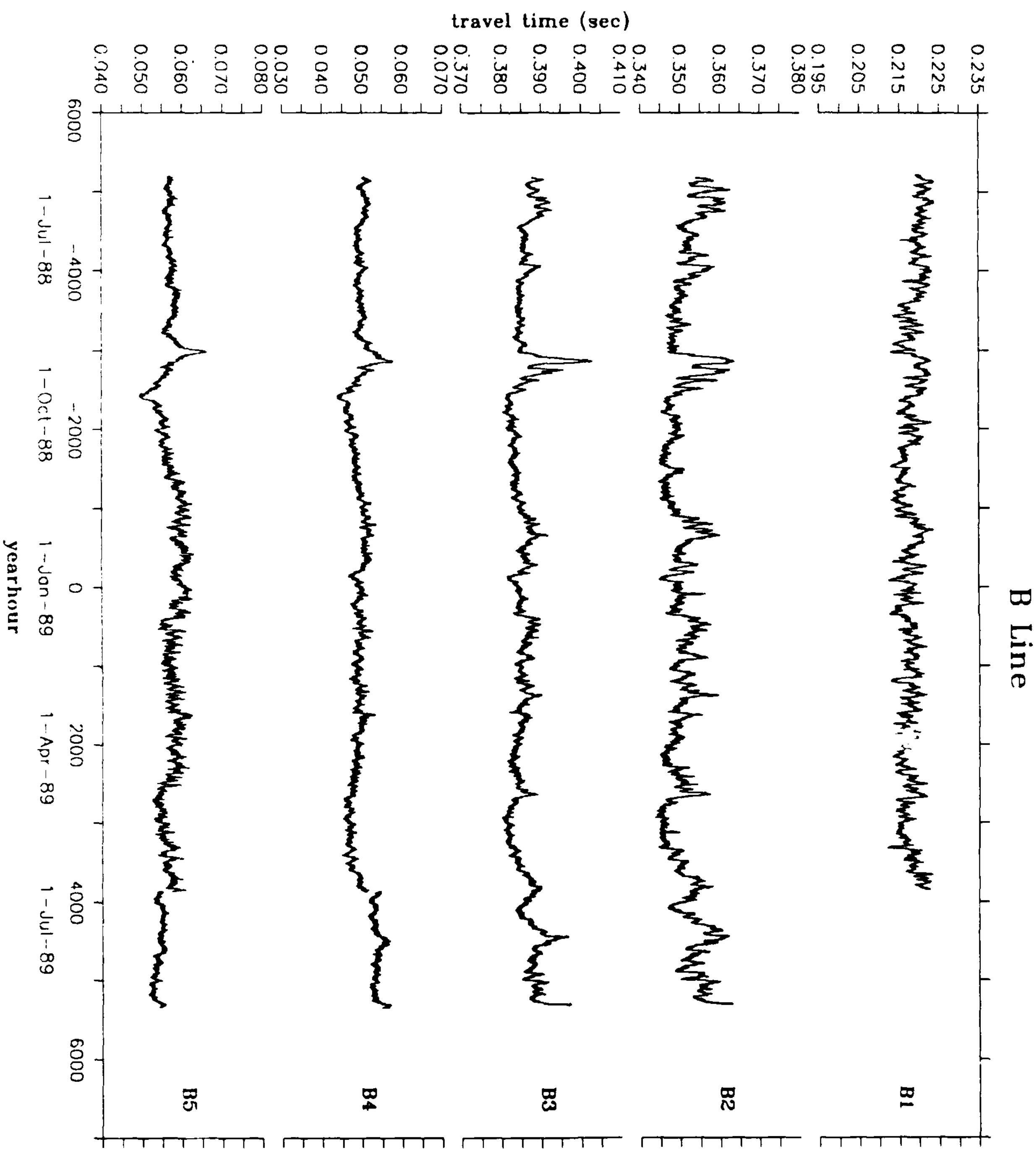


Figure 10.1: Half-Hourly Travel Times. B line

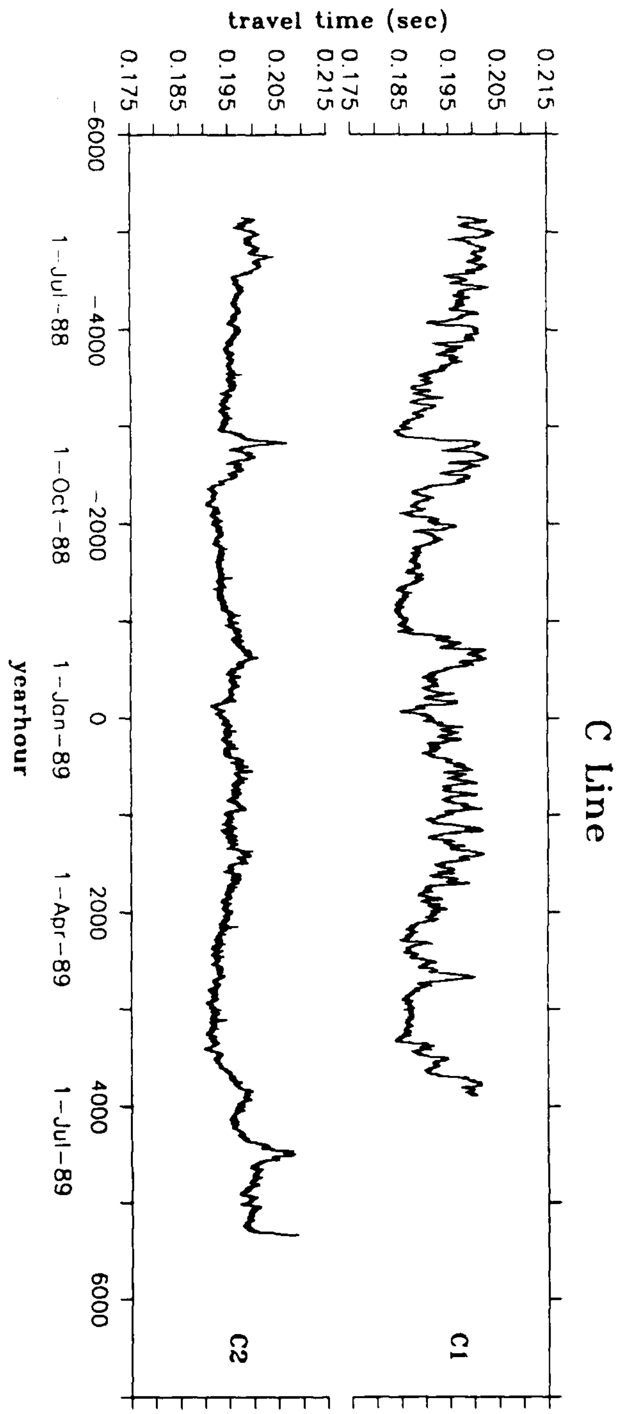


Figure 10.2: Half-Hourly Travel Times. C line

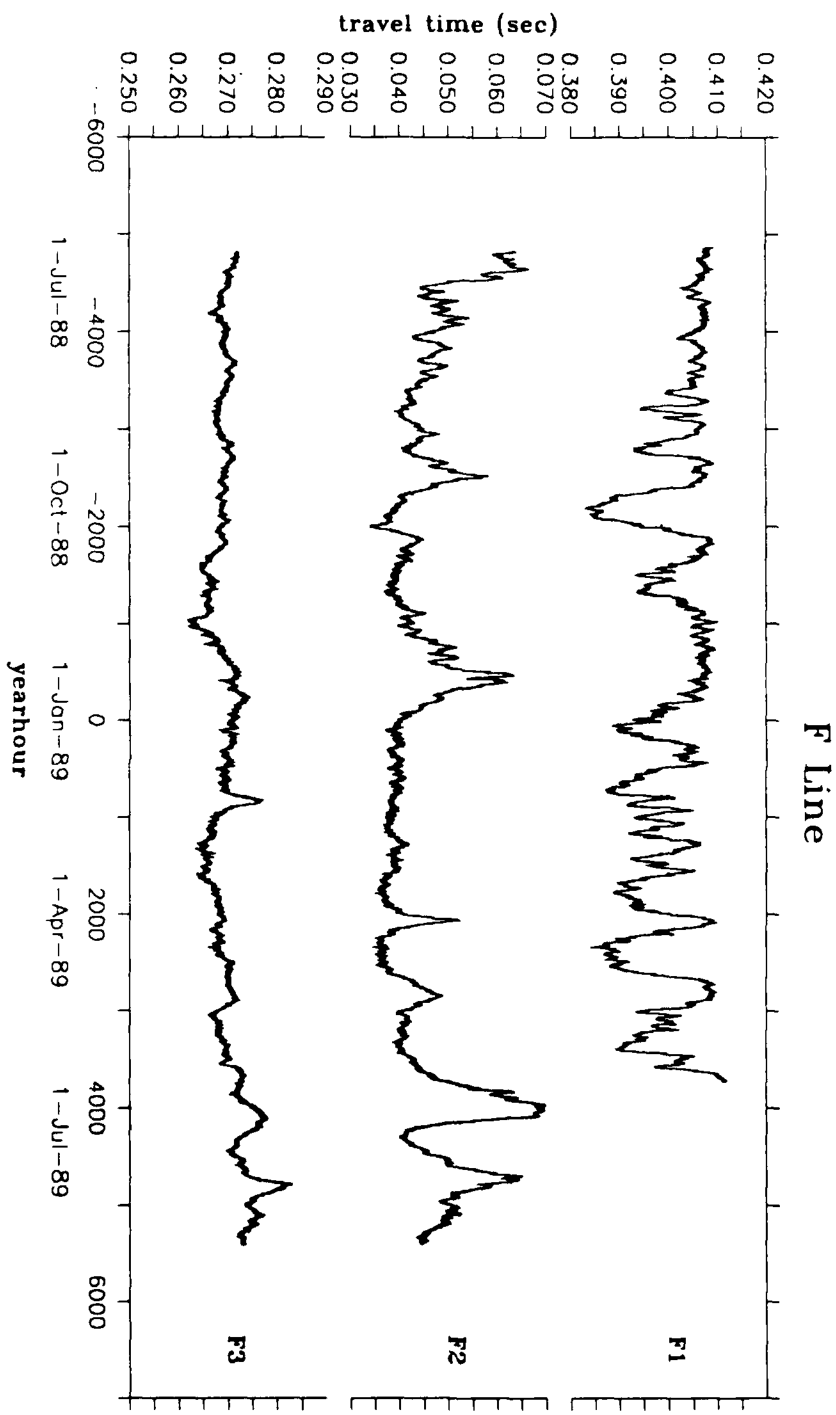


Figure 10.3: Half-Hourly Travel Times. F line

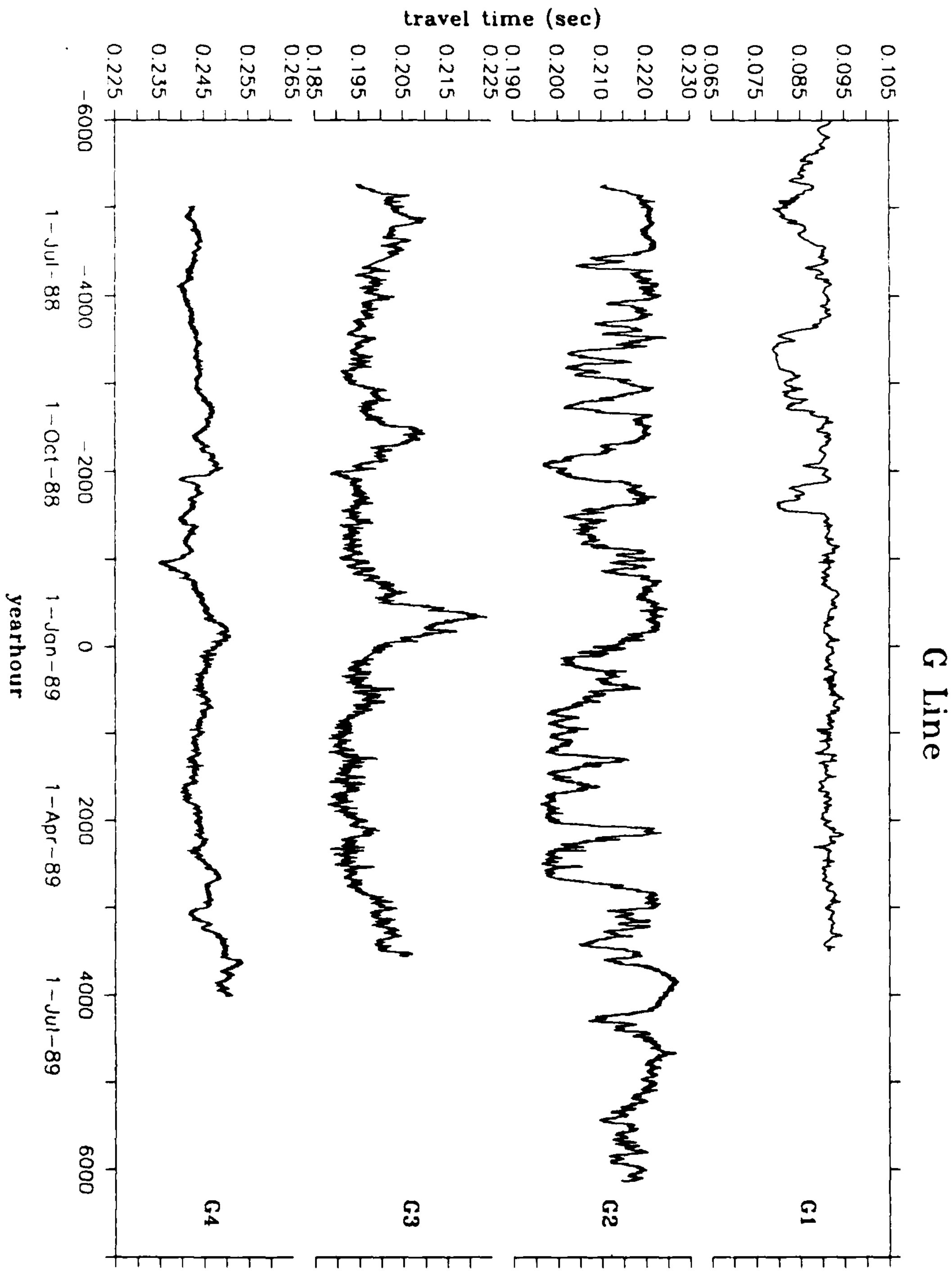


Figure 10.4: Half-Hourly Travel Times. G line

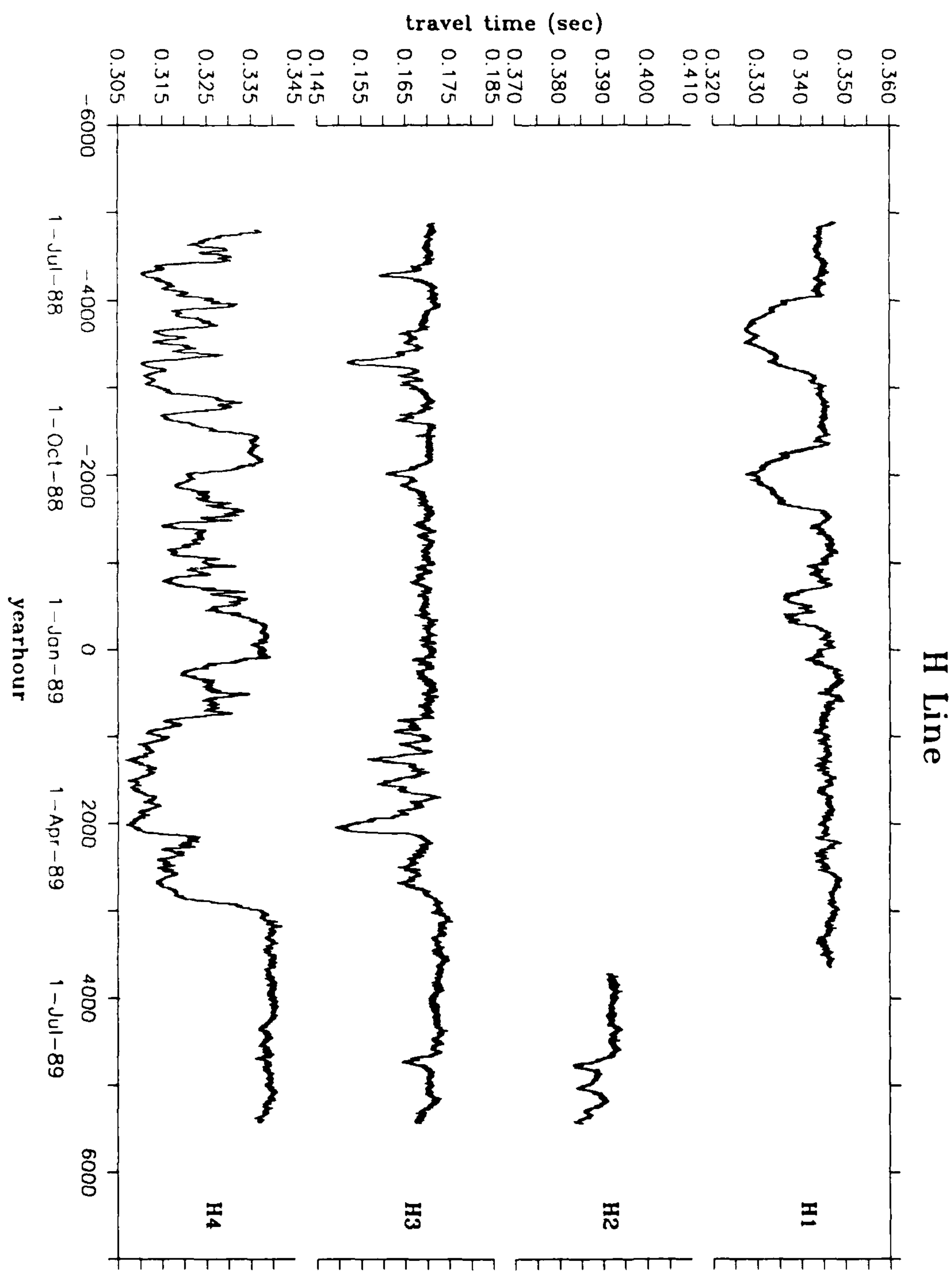
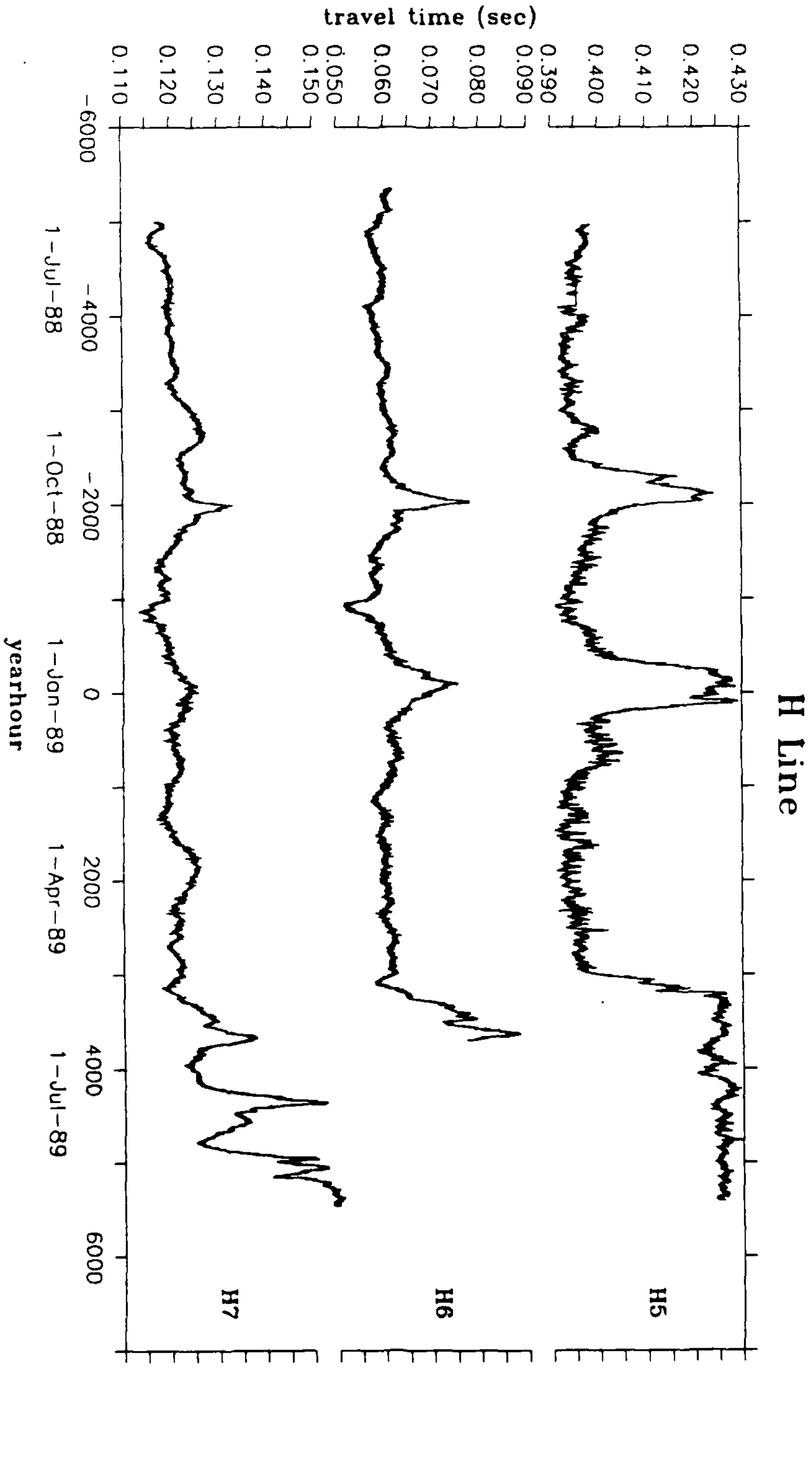


Figure 10.5: Half-Hourly Travel Times. H line


H Line
travel time (sec)
yearhour
H5
H6
H7
1-Jul-88
1-Oct-88
1-Jan-89
1-Apr-89
1-Jul-89
-6000
-4000
-2000
0
2000
4000
6000
0.430
0.420
0.410
0.400
0.390
0.090
0.080
0.070
0.060
0.050
0.150
0.140
0.130
0.120
0.110

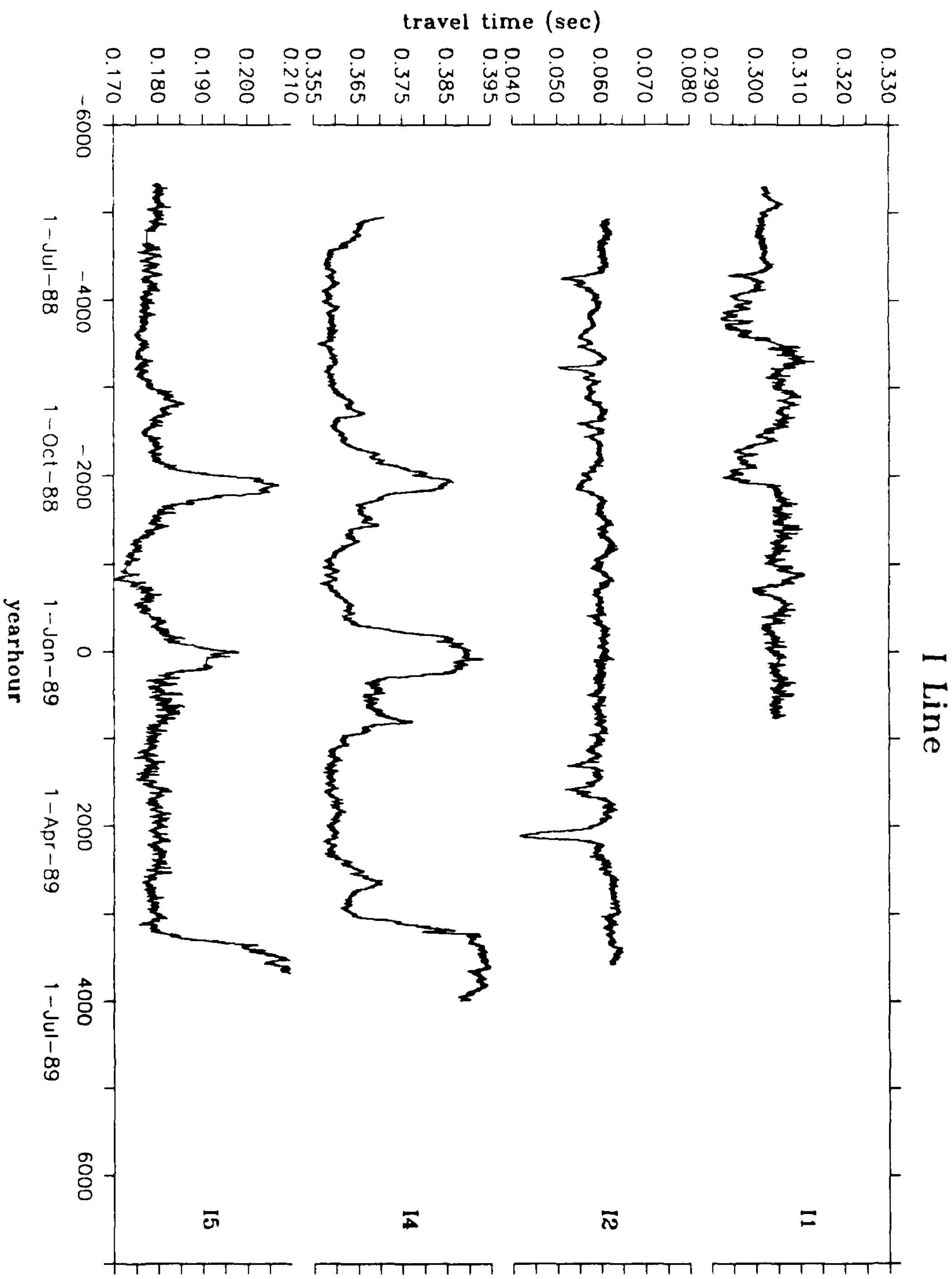


Figure 10.6: Half-Hourly Travel Times. I line

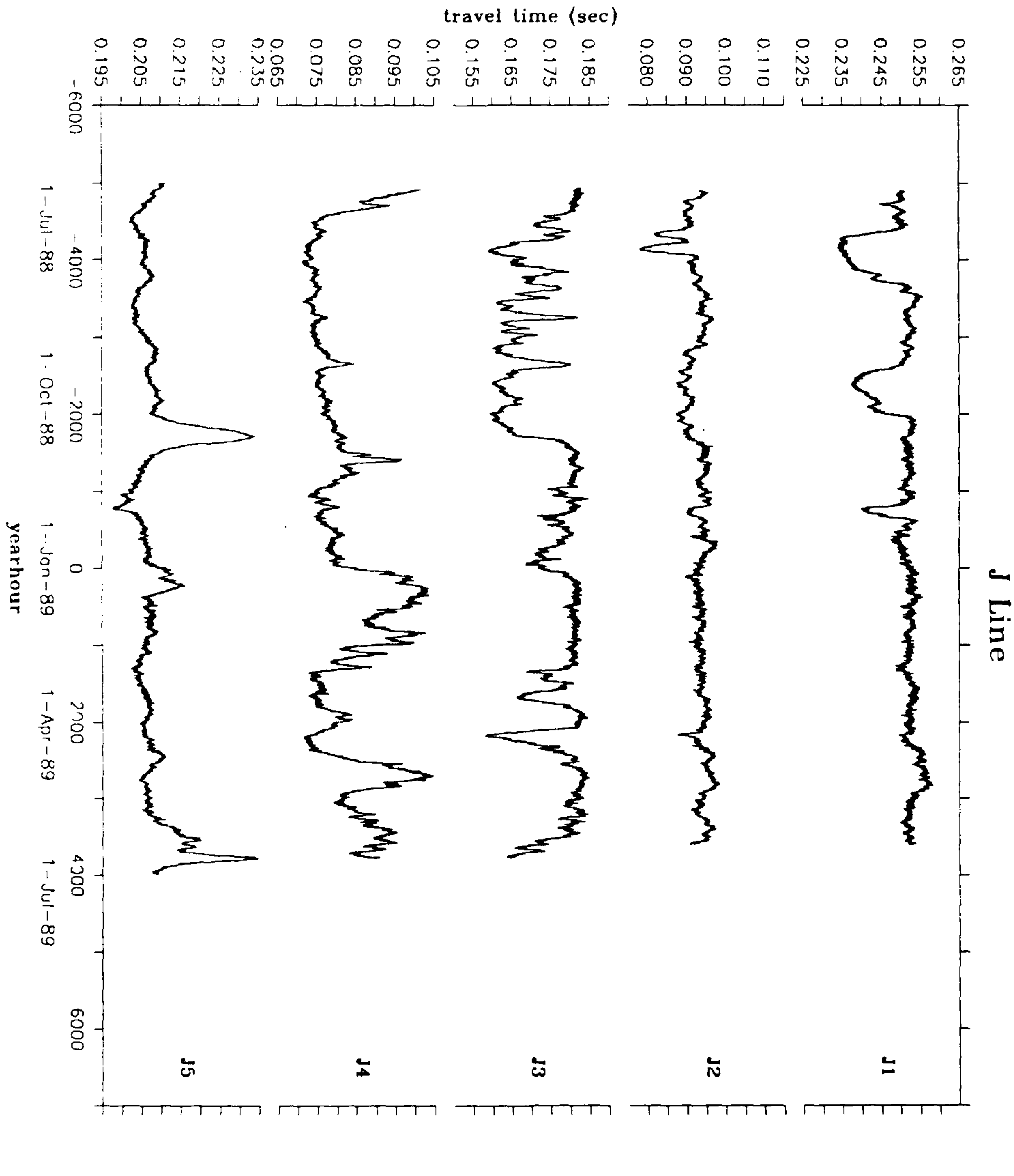


Figure 10.7: Half-Hourly Travel Times. J line

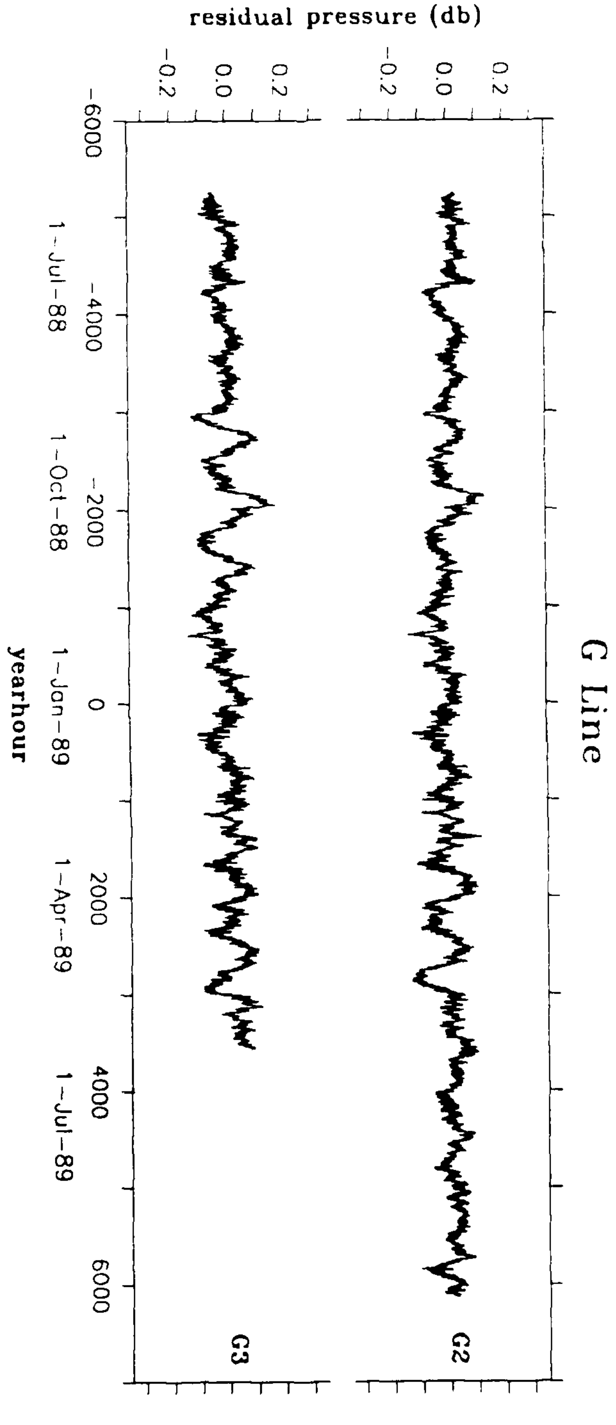


Figure 11.1: Half-Hourly Residual Bottom Pressure. G line

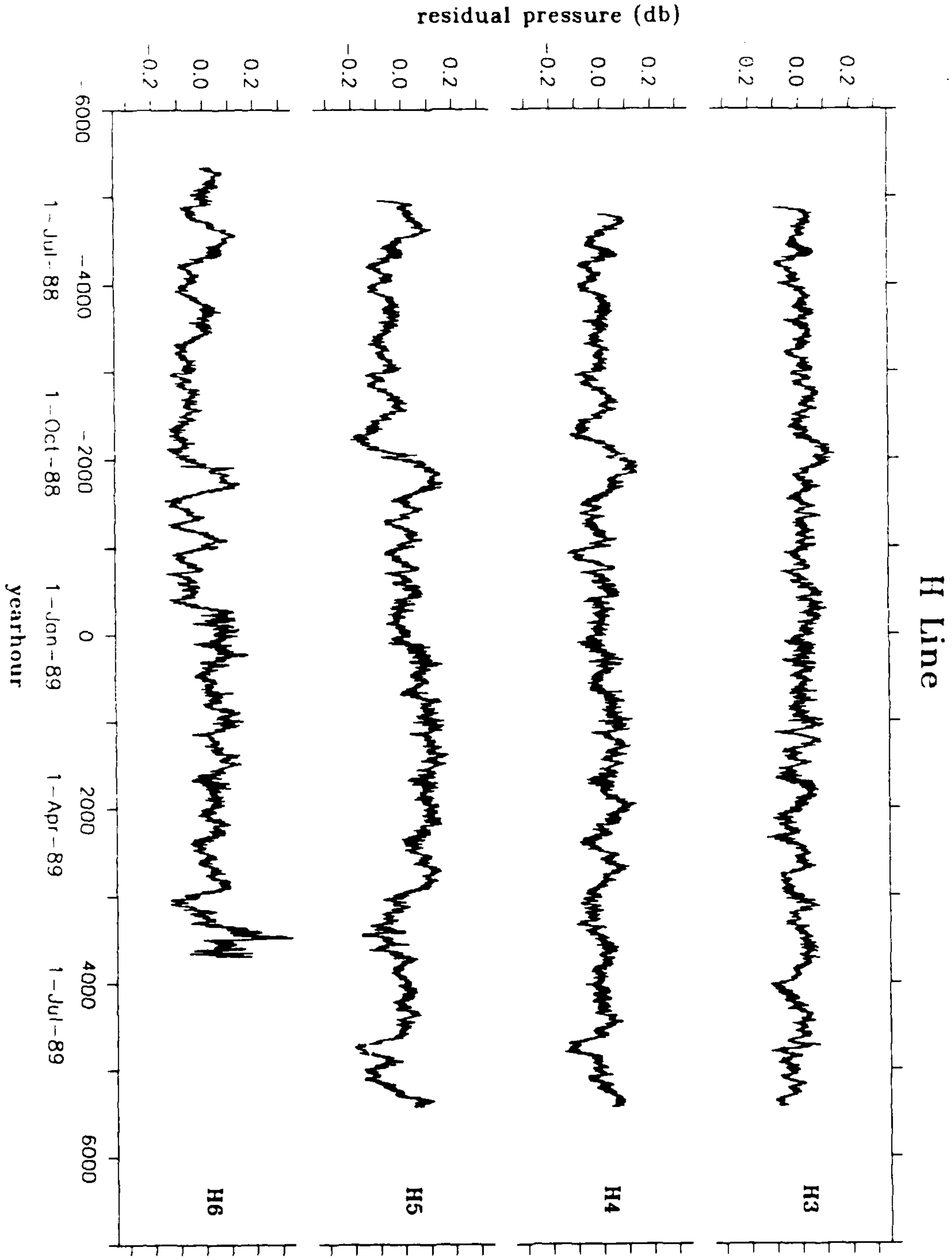


Figure 11.2: Half-Hourly Residual Bottom Pressure. H line

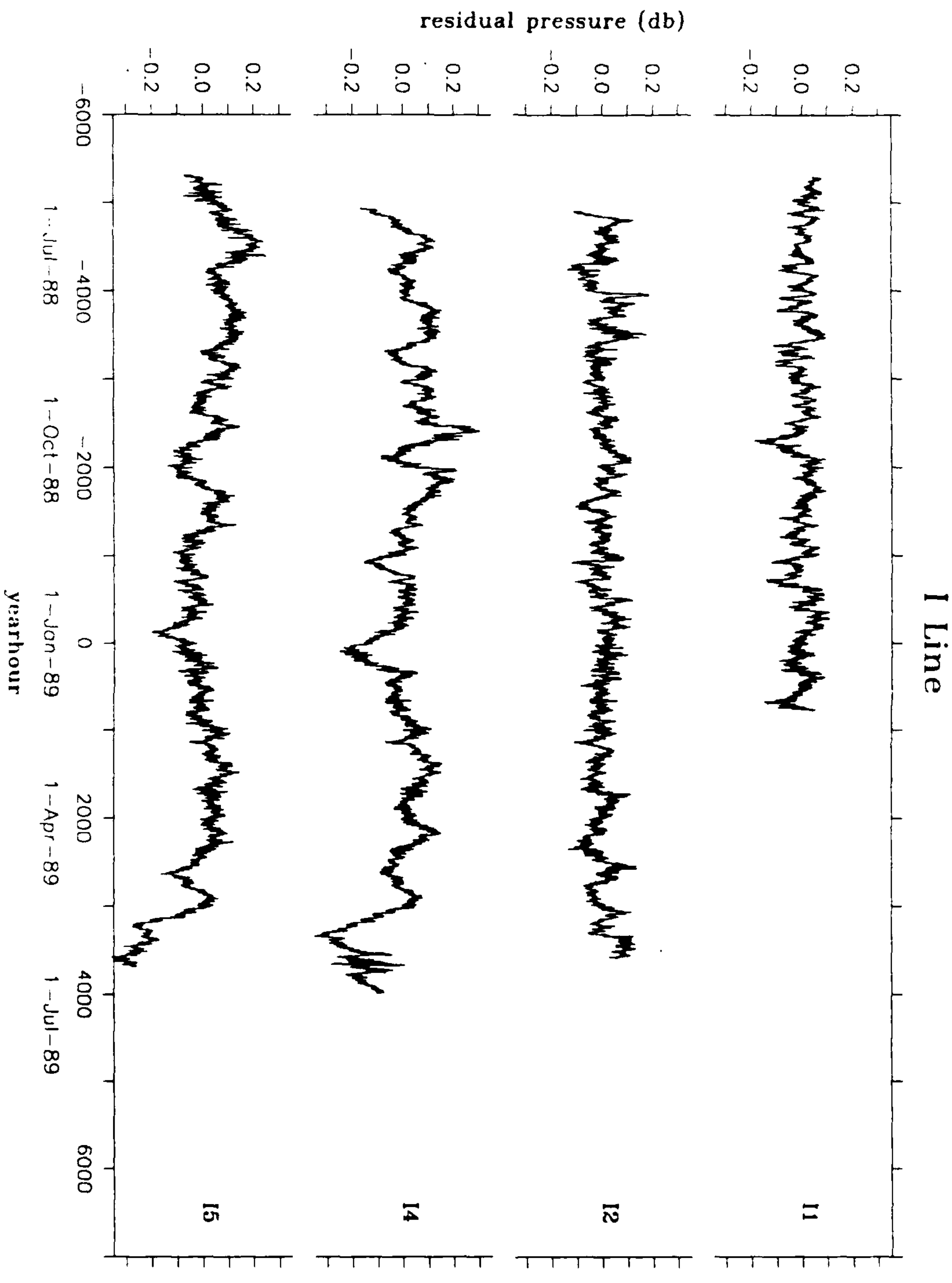


Figure 11.3: Half-Hourly Residual Bottom Pressure. I line

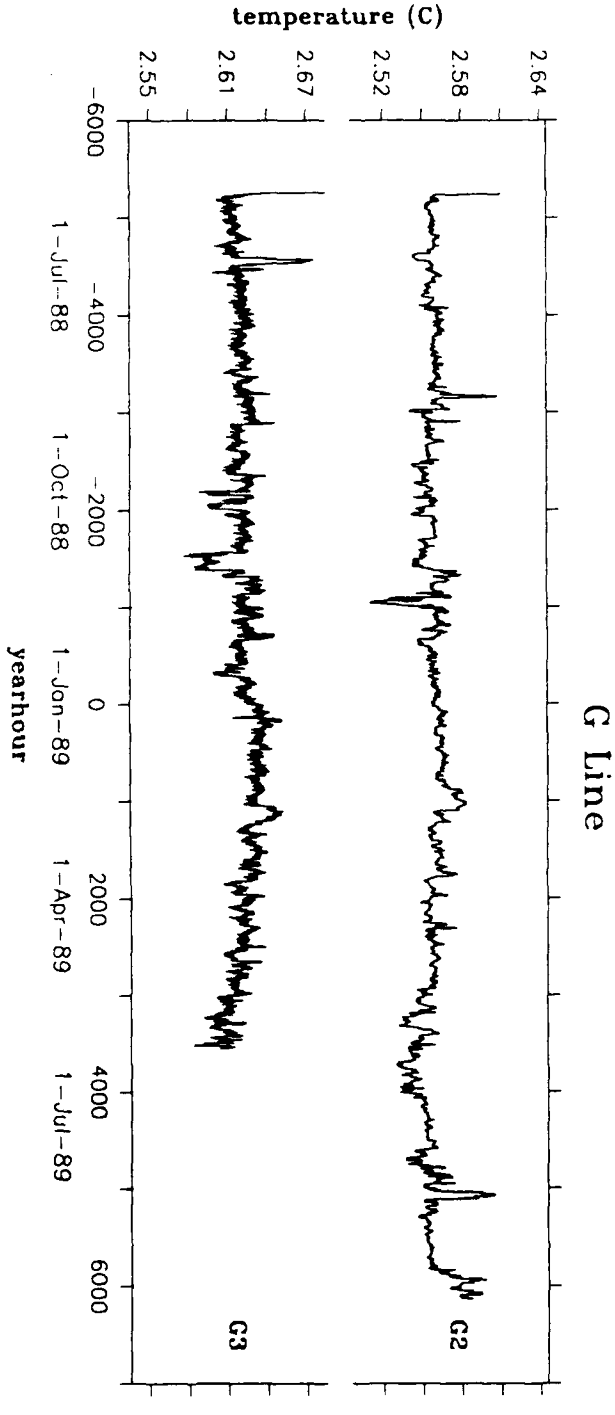


Figure 12.1: Half-Hourly Temperature. G line

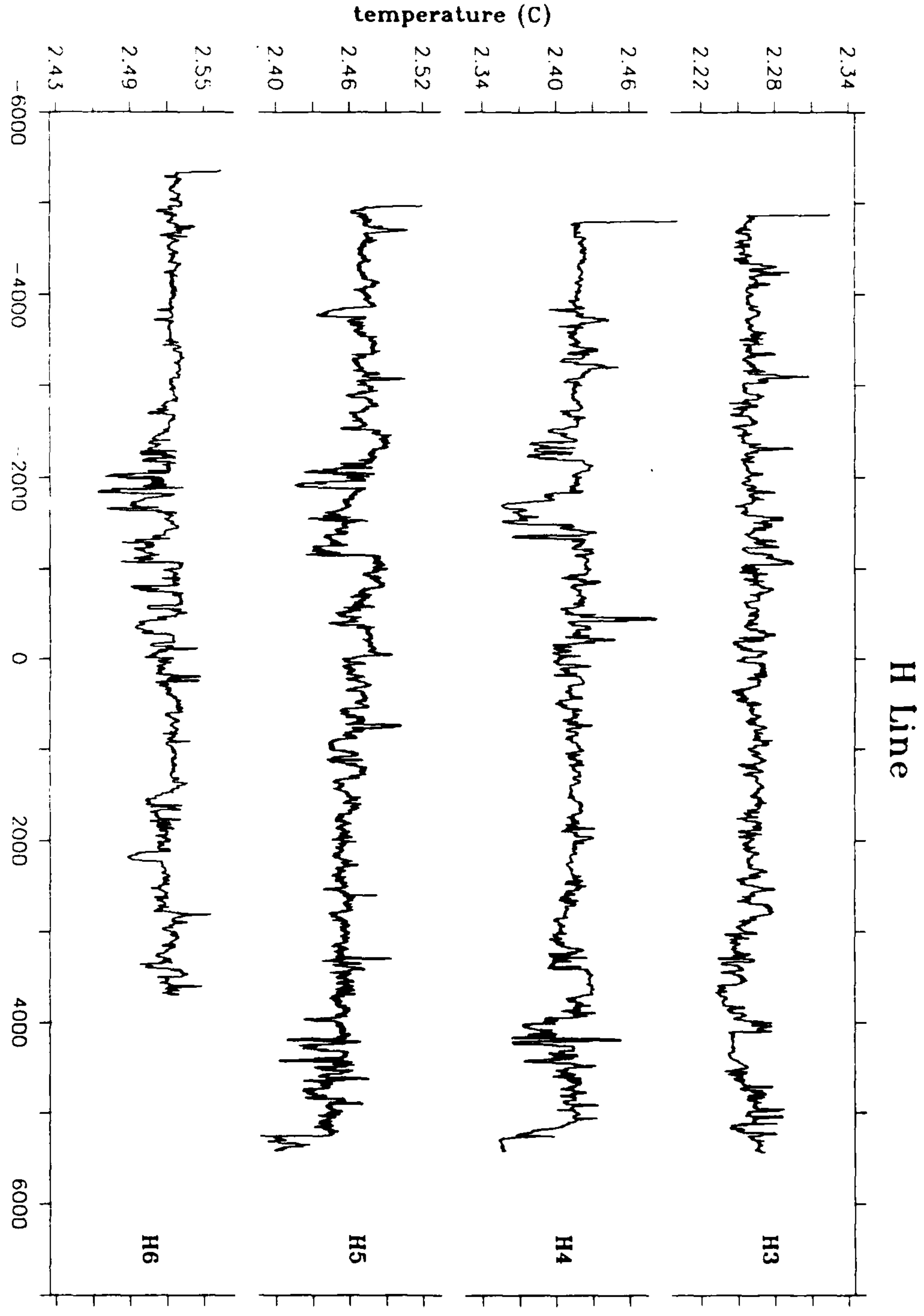


Figure 12.2: Half-Hourly Temperature. H line

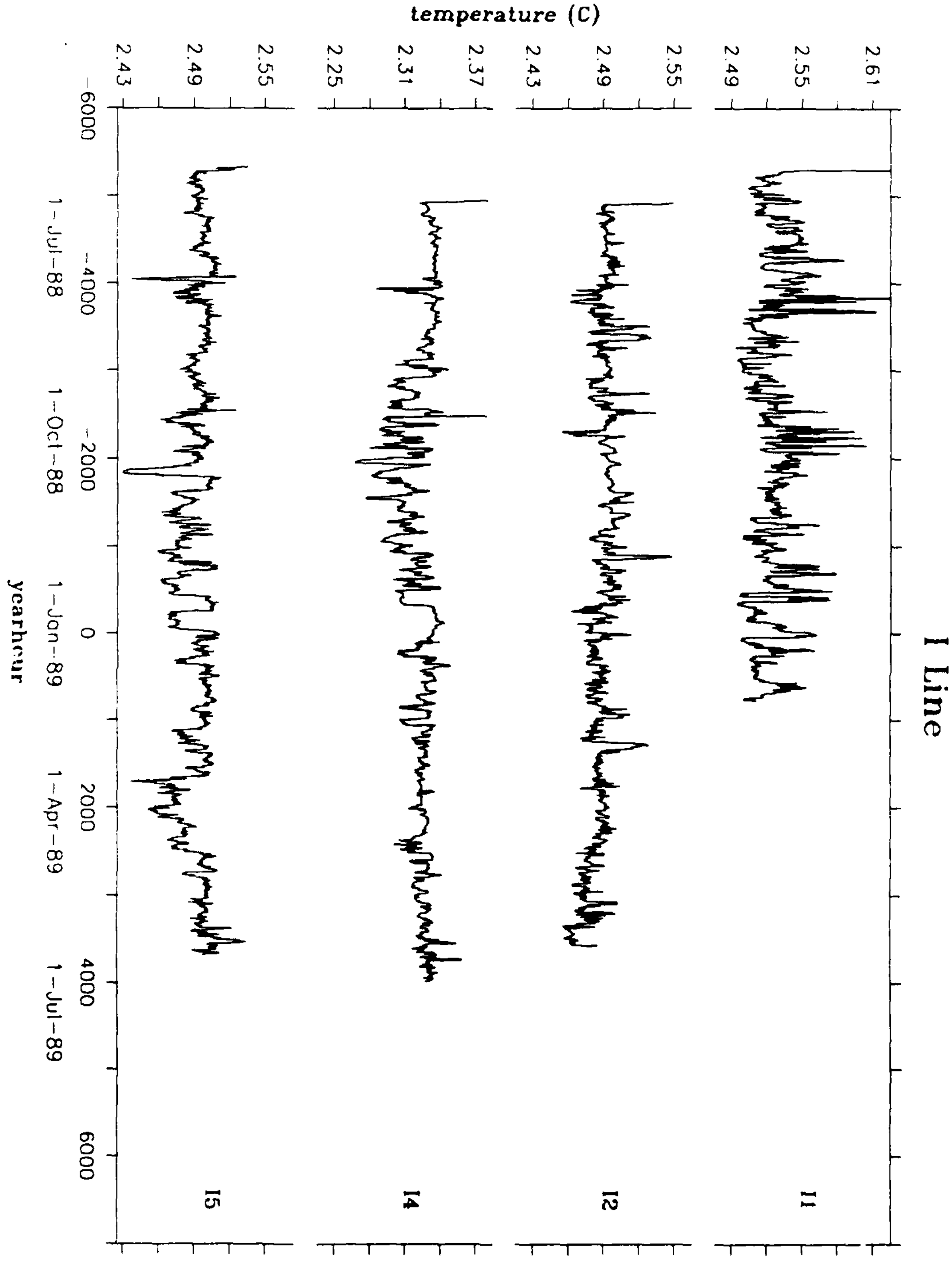


Figure 12.3: Half-Hourly Temperature. I line

5 40HRLP Line Plots

Thermocline depth, residual bottom pressure, and temperature are plotted by, grouped according to instrument - line, B,...J. Line plots display all records in a given line on a single page (except H line which was presented in two pages). All line plots have the time axis running from -6000 hr to 7000 hr in increments of 1000 hr. As with the individual plots, labels associating calendar dates with yearhours are centered beneath the appropriate location.

For temperature and residual bottom pressure the vertical axes for each instrument in the line should be the same as those used in the individual plots (section 3). The vertical axis for Z_{12} is fixed as ranging from 1000m depth to the surface in increments of 100 m.

The individual records that compose the line plots are labeled with the site at the right (yearhour=6500, and centered in the record's vertical axis). It should also be noted that the records of Z_{12} records of H7_207 and H7_210 were merged, plotted together in the same panel rather than apart. B4_207 and B4_210; and B5_207 and B5_210 were treated similarly.

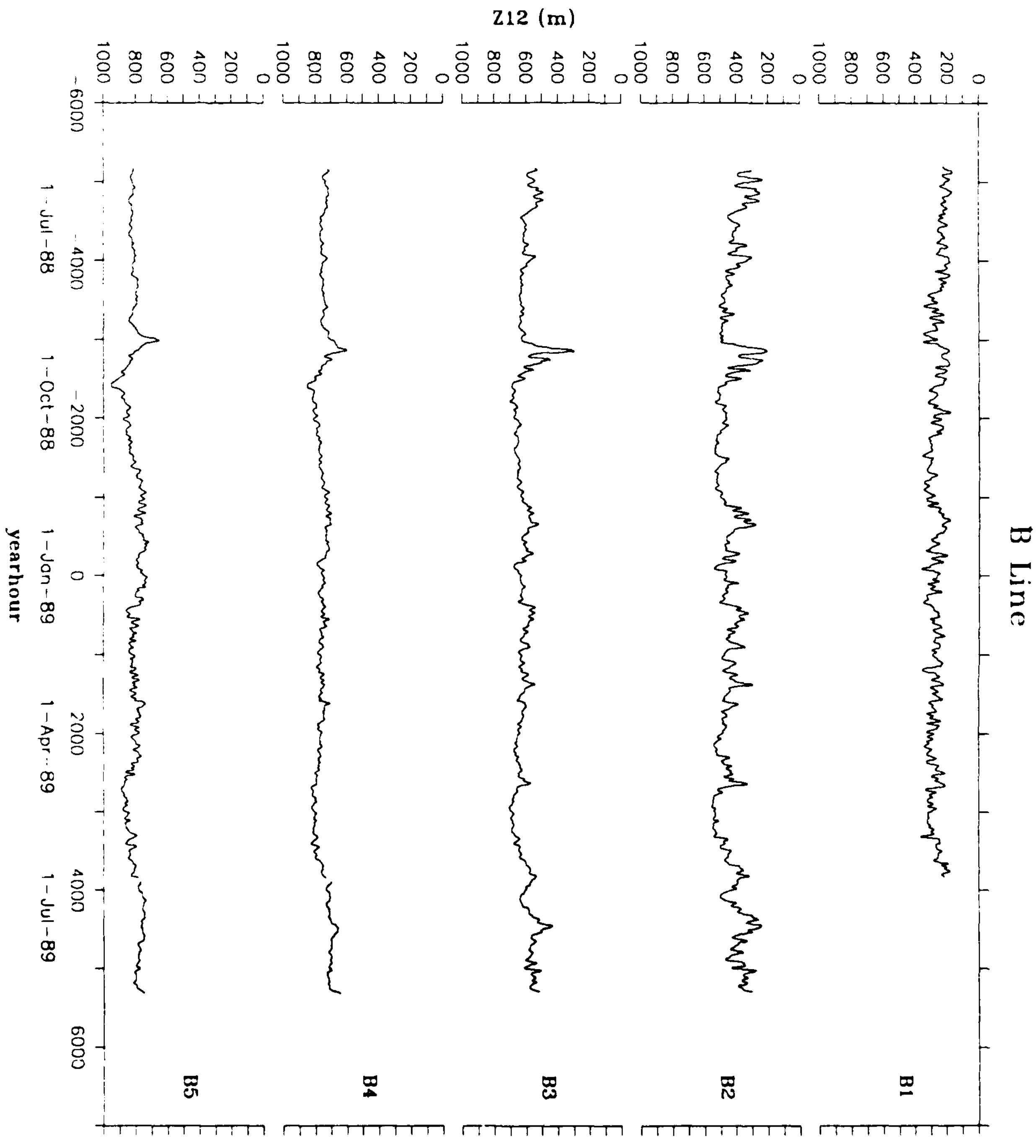


Figure 13.1: 40HRLP Z_{12}. B line

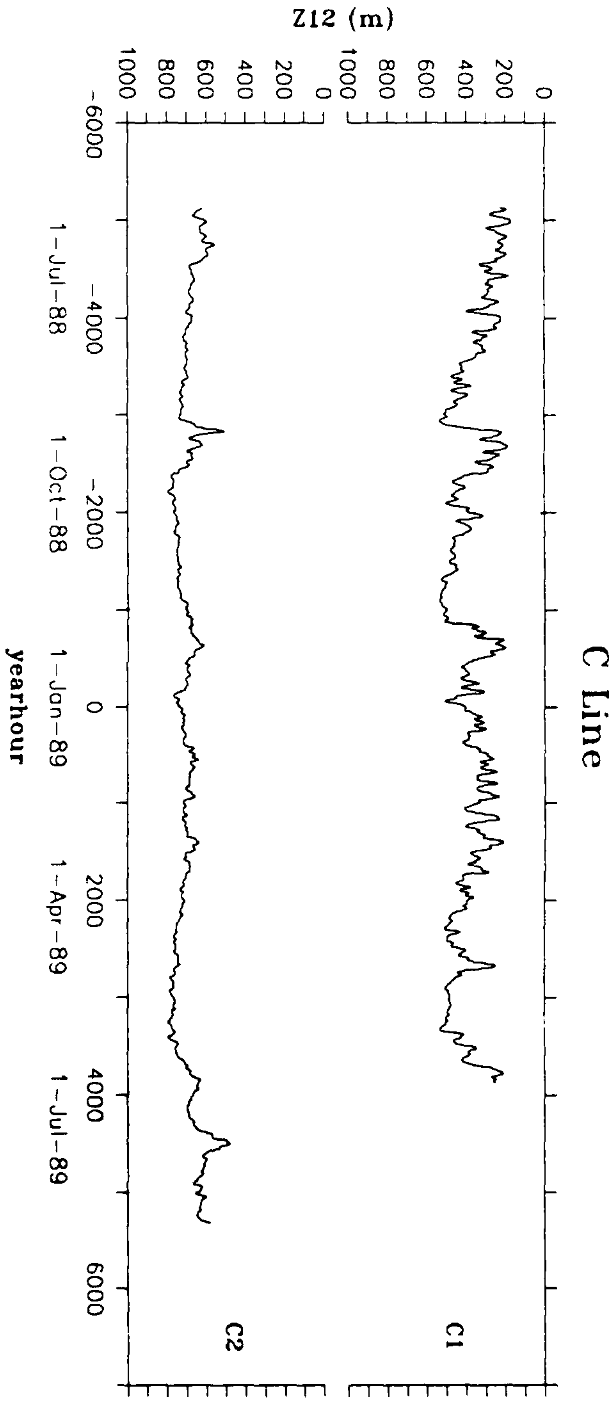


Figure 13.2: 40HRLP Z_{12}. C line

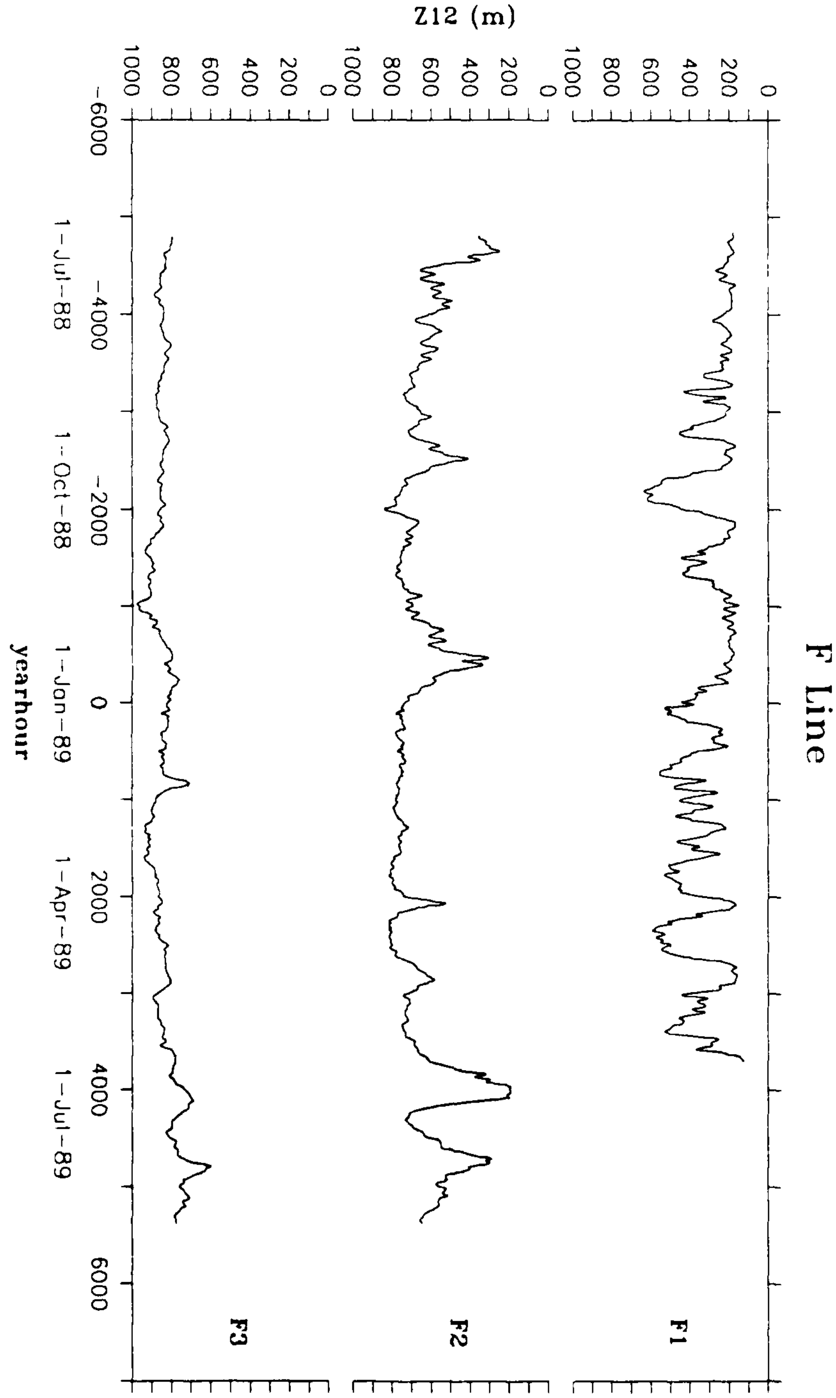


Figure 13.3: 40HRLP Z_{12}. F line

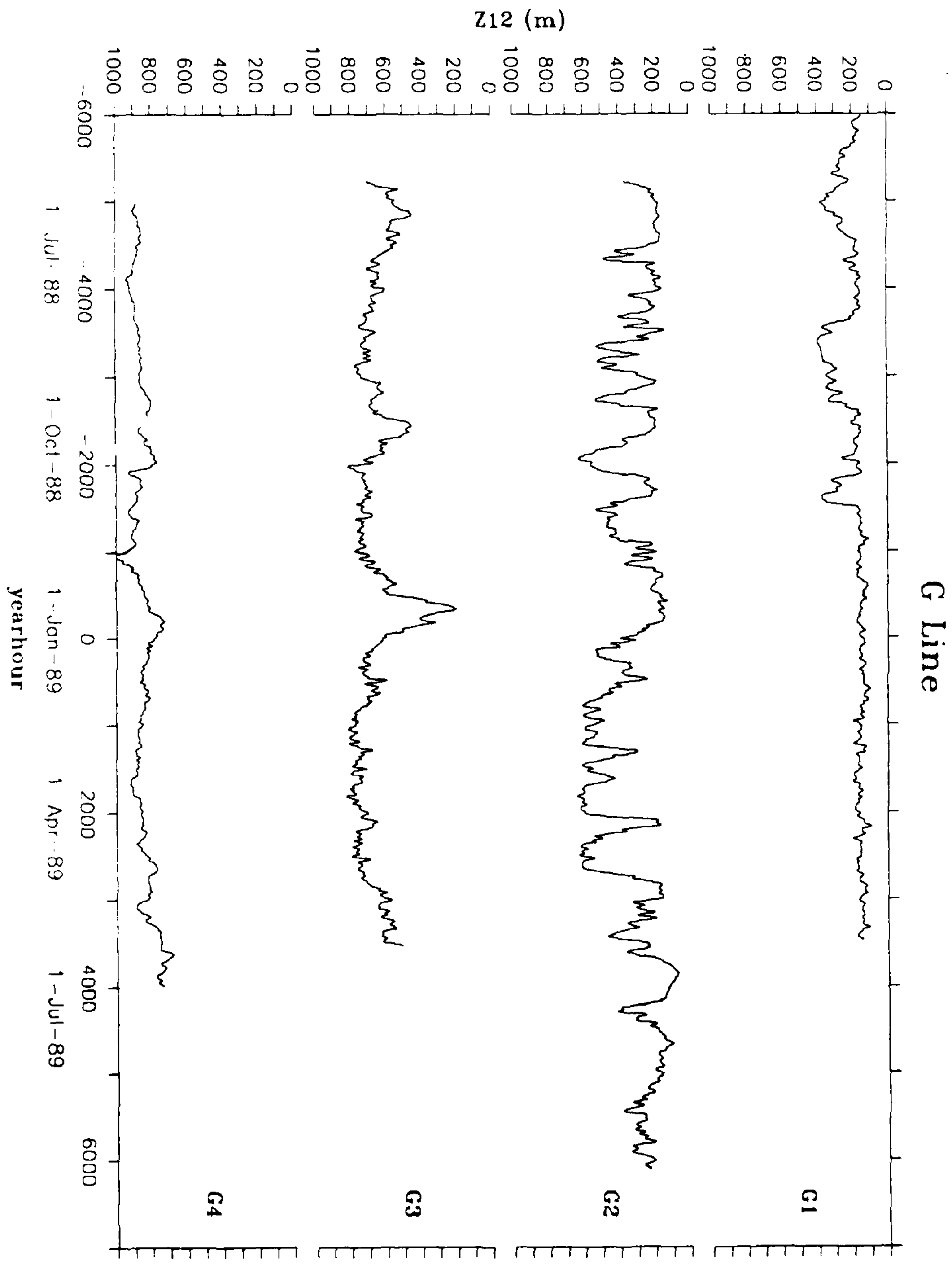


Figure 13.4: 40HRLP Z_{12}. G line

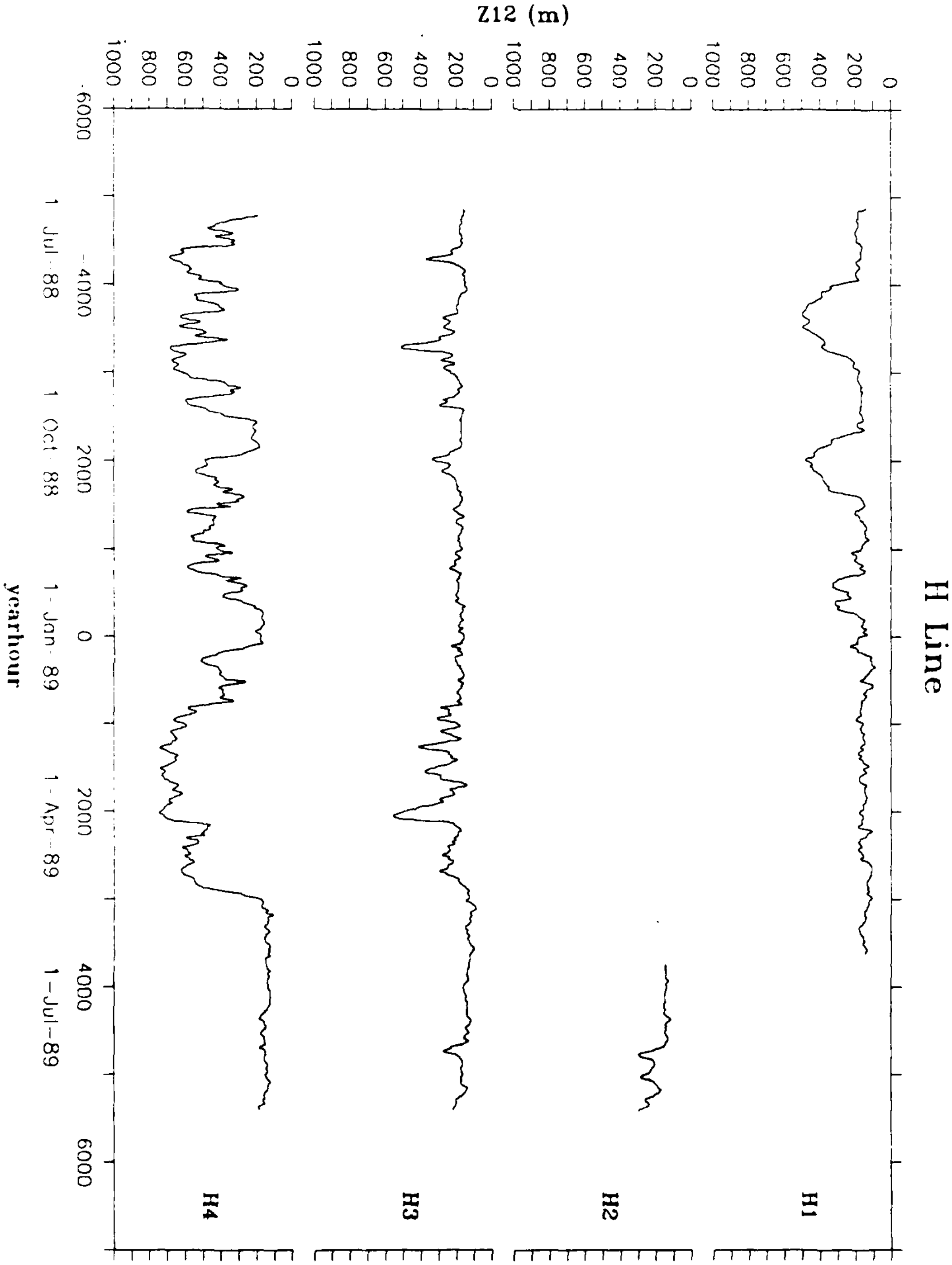
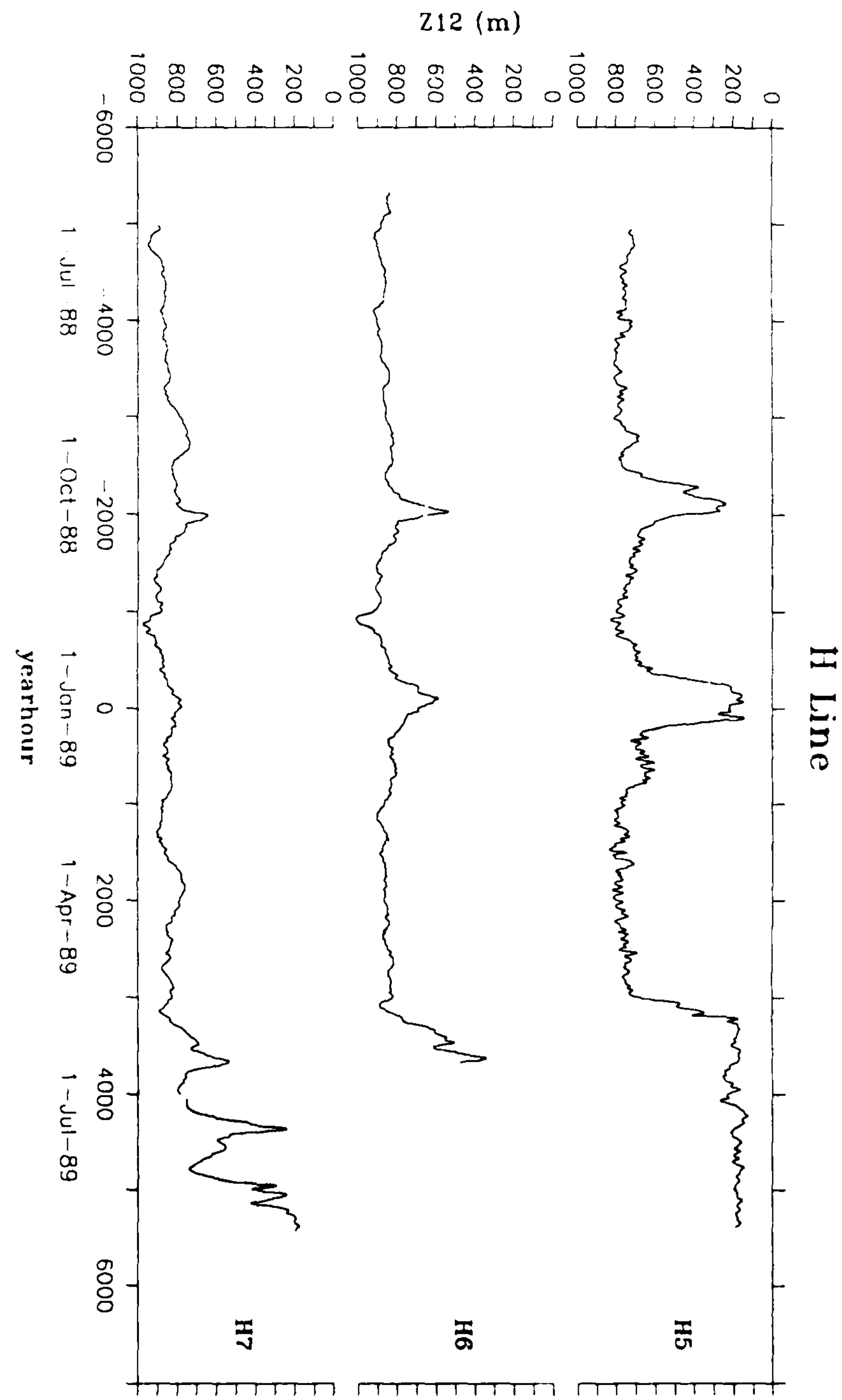


Figure 13.5: 40HRLP Z_{12}. H line


H Line
Z12 (m)
H5
H6
H7
0
200
400
600
800
1000
-6000
-4000
-2000
0
2000
4000
6000
1-Jul-88
1-Oct-88
1-Jan-89
1-Apr-89
1-Jul-89
yearhour

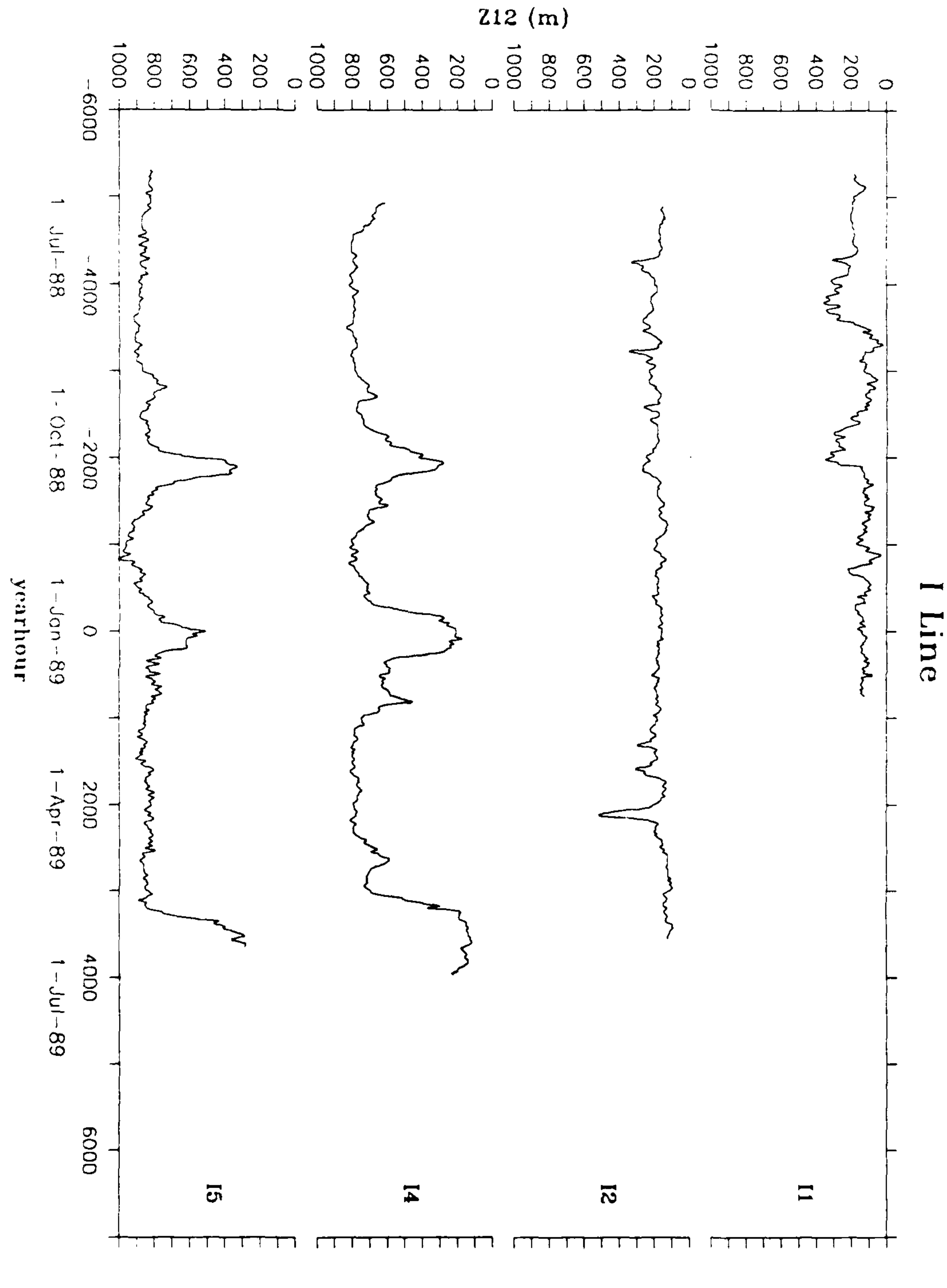


Figure 13.6: 40HRLP Z_{12}. I line

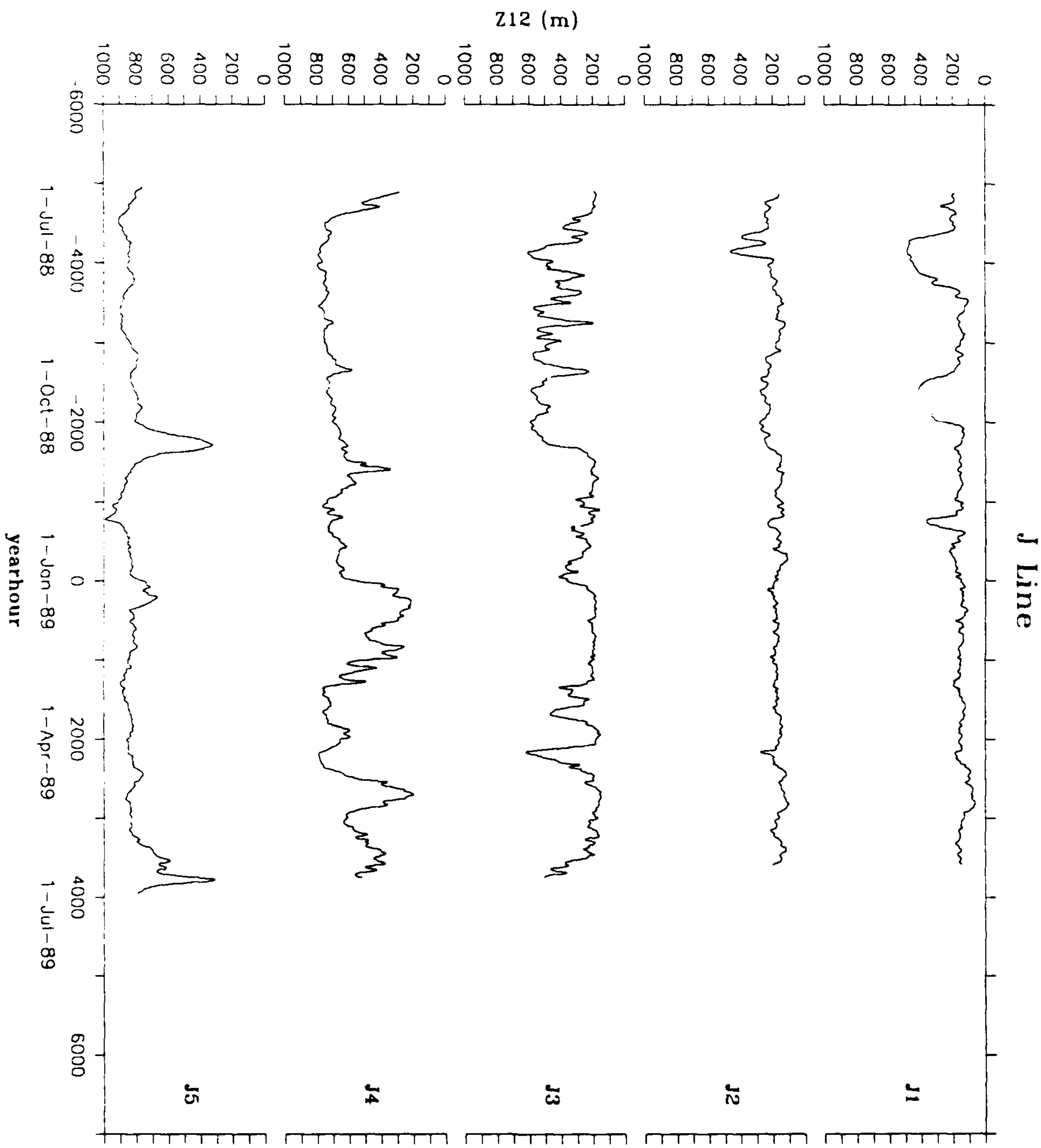


Figure 13.7: 40HRLP Z_{12}. J line

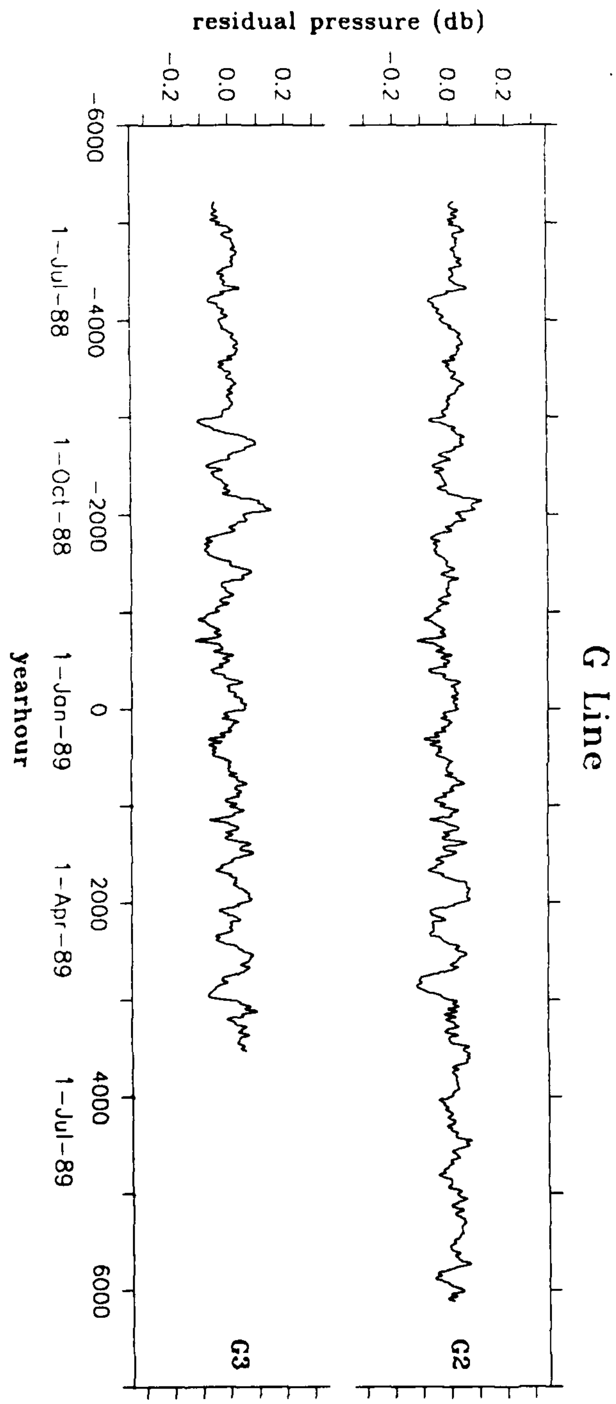


Figure 14.1: 40HRLP Residual Bottom Pressure. G line

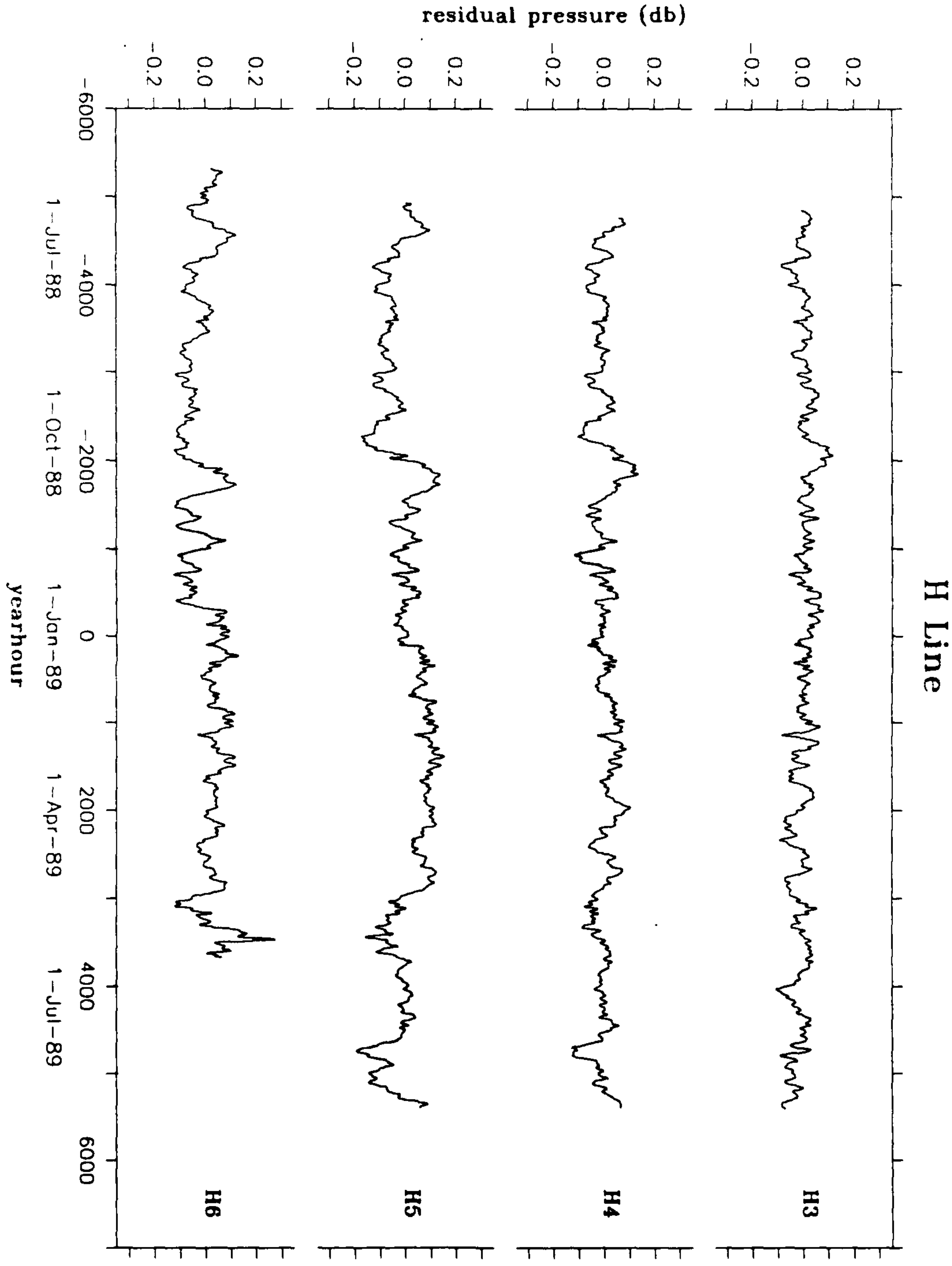


Figure 14.2: 40HRLP Residual Bottom Pressure. H line

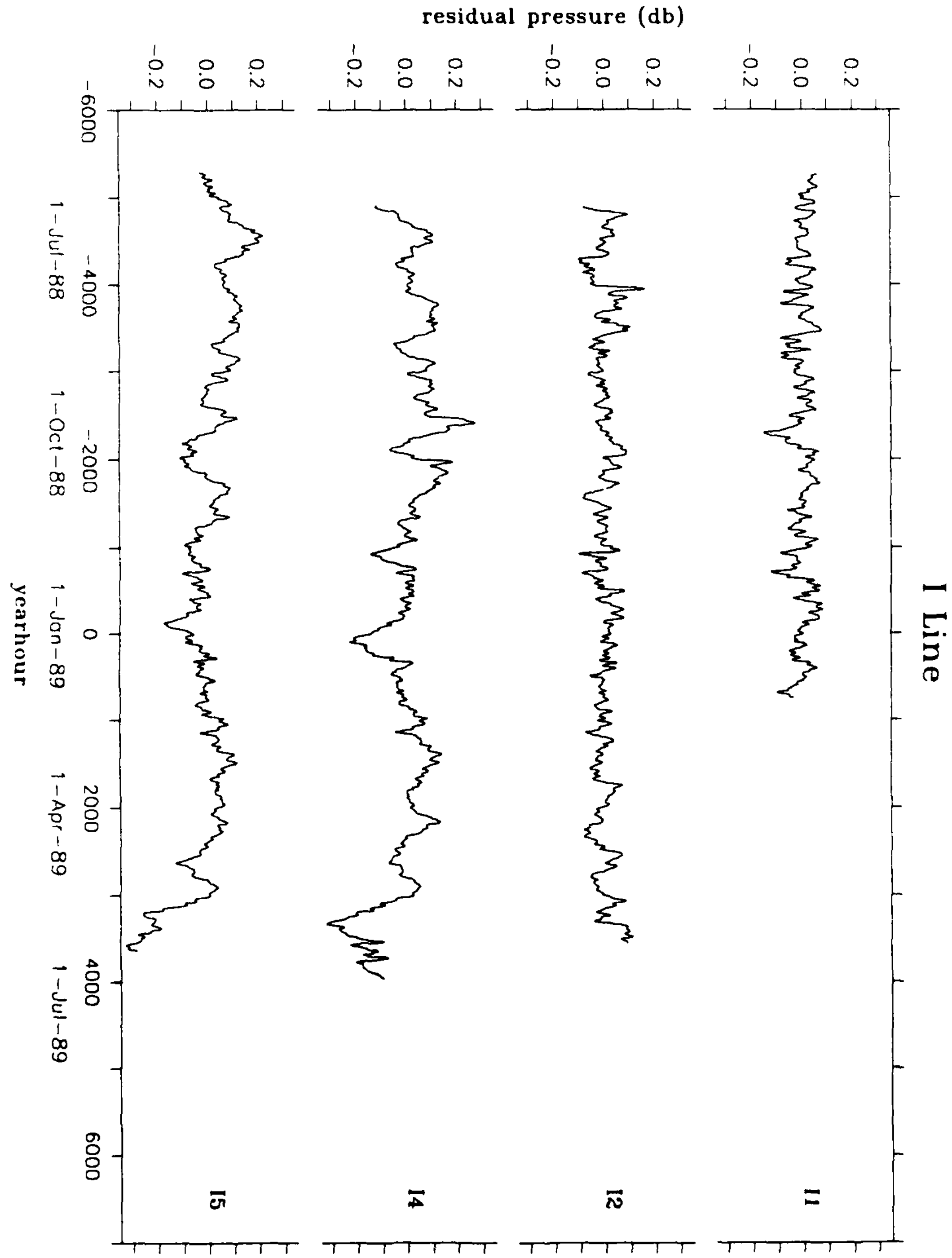


Figure 14.3: 40HRLP Residual Bottom Pressure. I line

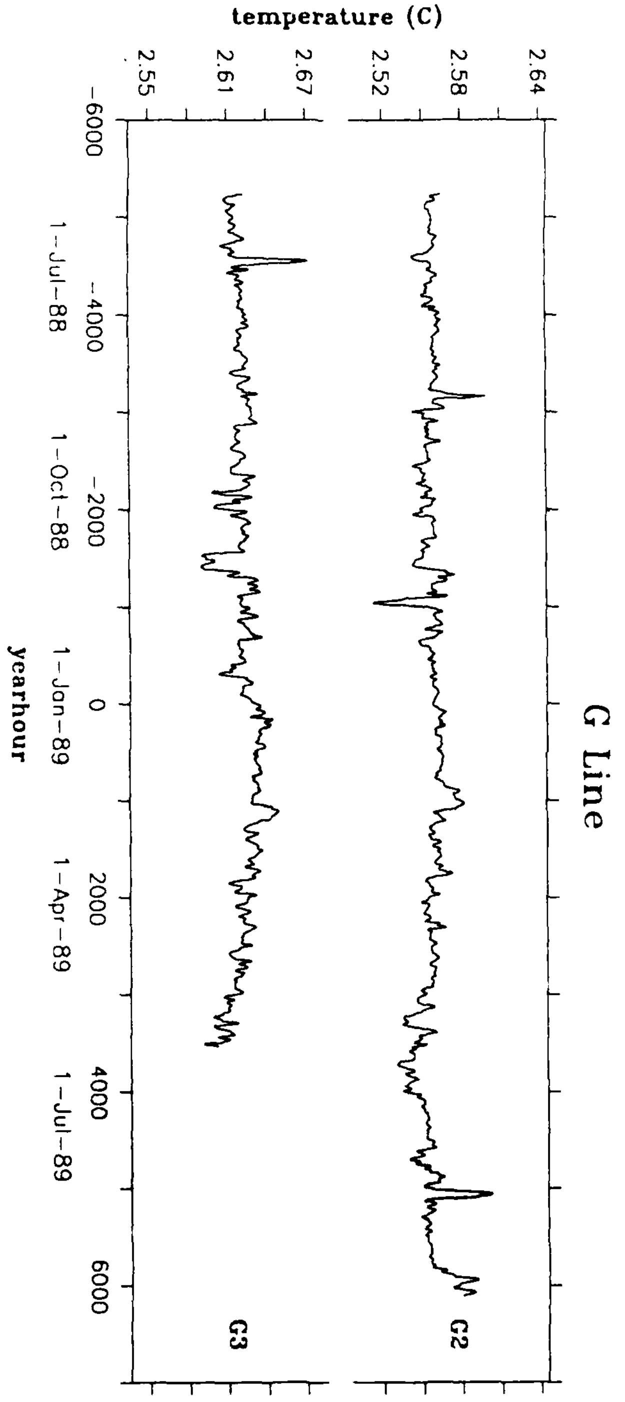


Figure 15.1: 40HRLP Temperature. G line

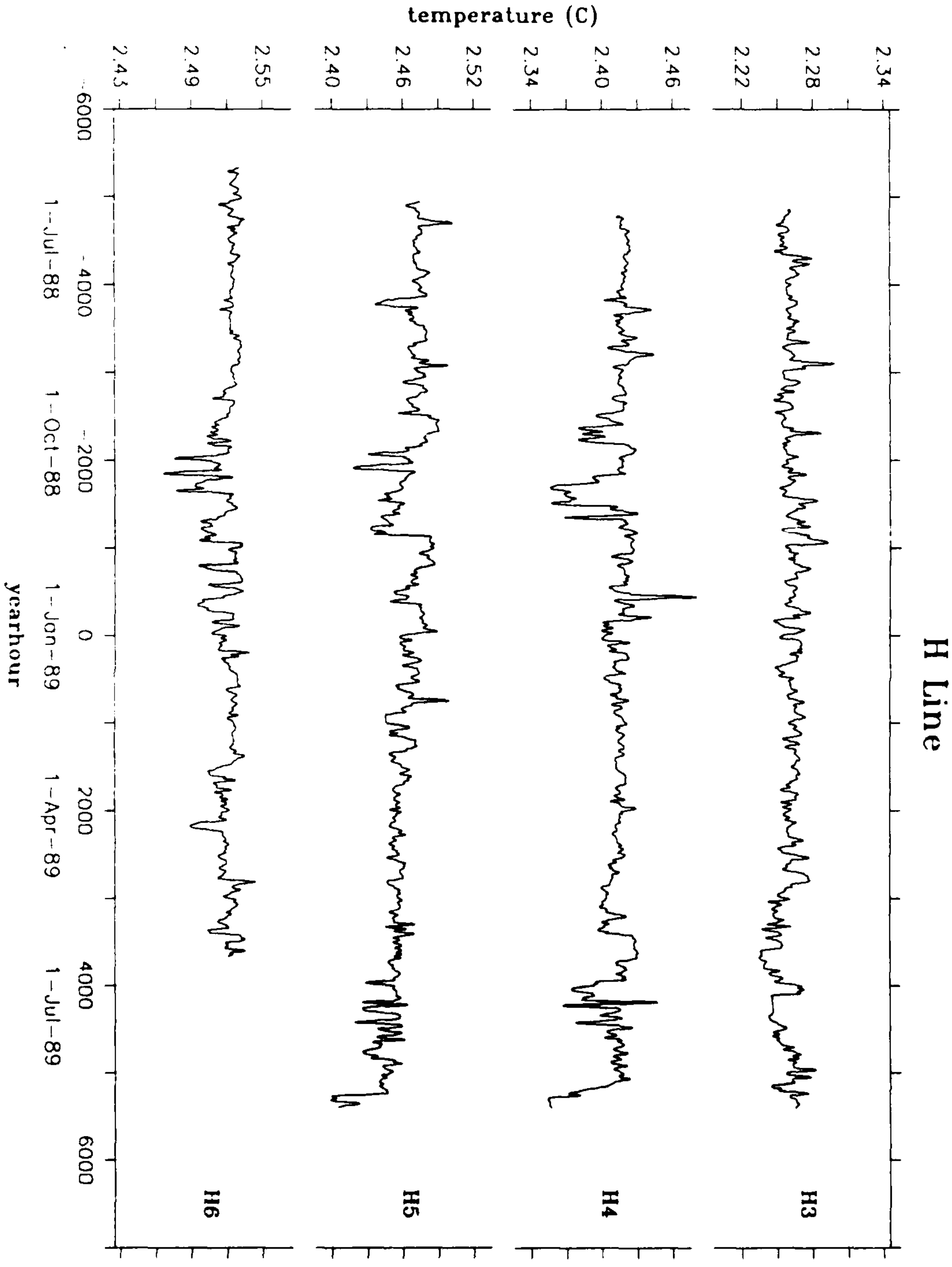


Figure 15.2: 40HRLP Temperature. H line

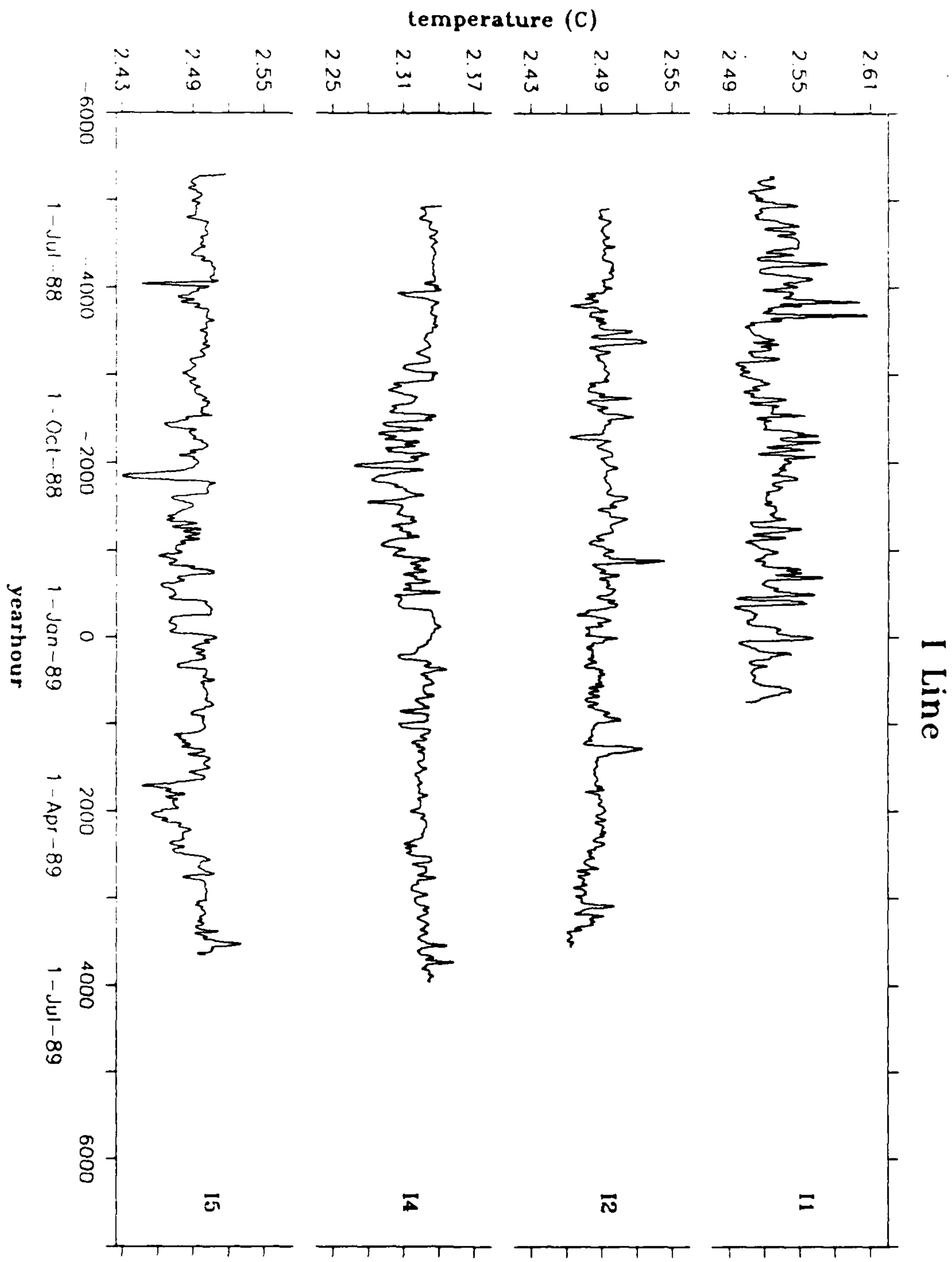


Figure 15.3: 40HRLP Temperature. I line

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The SYNoptic Ocean Prediction experiment (SYNOP) was undertaken with the goal that increased understanding of the Gulf Stream obtained through coordinated observations could be integrated with numerical models, including predictive models of the Gulf Stream. Our moored experiment, which began in fall of 1987, consists of two separate arrays in the Gulf Stream as part of the SYNOP program. The "Inlet" array of inverted echo sounders (IES) and deep current meters measure key parameters that describe the variability of the Gulf Stream and deep western boundary current (DWBC) near Cape Hatteras. In this region the Gulf Stream first flows into deeper water and crosses over the DWBC. The "Central" array of IESs, in a 350 km square centered on the Gulf Stream near 68°W, monitors the thermocline structure of the Gulf Stream in the region of large meanders and frequent interactions with rings. The array also contains twelve tall current meter moorings, that reach into the Gulf Stream core. Additionally most of the IESs in the interior of the array are outfitted with bottom pressure recorders (PIES).

IES data recovered during the summer of 1989 is documented here by plots and tables of basic statistics and pertinent deployment information. Altogether 33 IES records are presented, plus pressure records at 10 sites. The echo sounders were recovered during two cruises of the RV Oceanus, OC207 (26-May-89 to 21-Jun-89) and OC210 (8-Aug-89 to 1-Sep-89). The plots are time series of measured travel time, pressure, temperature; the residual pressure; and low-pass filtered records of residual pressure, thermocline depth, and temperature. A brief description of the experiment is given, the standard steps of data processing and special processing for three IES records that had different problems are discussed.

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